ANNUAL REPORT

OF THE

BOARD OF DIRECTORS

OF THE

Chicago Astronomical Society

TOGETHER WITH THE

REPORT OF THE DIRECTOR

OF THE

DEARBORN OBSERVATORY,

1882.

CHICAGO:
KNIGHT & LEONARD, PRINTERS.
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FOR 1882.

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DIRECTOR OF OBSERVATORY.

PROF. G. W. HOUGH.

REAR VIEW OF THE CHICAGO UNIVERSITY,
SHOWING THE TOWER OF THE DEARBORN OBSERVATORY.

REPORT.

Annual Report of the Board of Directors
to the Chicago Astronomical Society:

Your directors take pleasure in reporting a very considerable improvement during the past year in the general condition of the Society's affairs.

The prompt response by some of its members and friends at the beginning of the year to the appeal for funds with which to pay for the new clocks and other equipments for time service, and the successful performance of that service, with the compensation therefor, have contributed greatly to this result.

It is known to the members of the Society that the Union Mutual Life Insurance Company has commenced proceedings against the Chicago University for foreclosure on a mortgage under which an indebtedness of about $150,000 is claimed.

This mortgage was made subsequently to the agreement made with the Astronomical Society by the University, under which the Society built and equipped its observatory, and while the Society was in actual possession and occupancy of Dearborn tower and appurtenances.

The facts in the case show, as we are advised, that the Insurance Company in consequence of such possession and occupancy, had legal notice of the rights of this Society to the perpetual use of the premises occupied by it, and these rights are defended and asserted by a bill of interpleader filed by this Society in connection with said foreclosure suit.

The Society is put to no expense in this litigation, as the

University is bound to protect it, and Messrs. Willard & Driggs, the solicitors of the University, have, without charge to the Society, prepared and filed all the papers in the case, and they and Hon. Thomas Hoyne are attending to the interests of the Society under the direction of Mr. Scammon.

The Society has during the past two years printed condensed reports of work done at your Observatory, but has not been free to incur such an expense as would have done fuller justice to the work performed, and to astronomical science; and your Directors recommend that the friends of the Society be asked to aid in printing a more complete report of that of the past year.

The Treasurer reports a balance on hand to the credit of the general fund of $1,216.11, and to the credit of a new subscription fund for the present year, the sum of $250.

Under a renewal of the contract with the city authorities, the time service will be continued through the current year.

The following gentlemen have become life members of the Society since the last annual meeting: John H. Dwight, Charles A. Mair, Norman B. Ream, Peter McGeoch, William C. Seipp.

Your Directors offer the results of the year as evidence that the Society needs only the hearty and active interest of its members and friends to become an institution in the work of which our city may take pride.

Prof. G. W. Hough, the Director in charge, has prepared a summary of his observations and studies during the year, and those of other gentlemen who have used your instruments, which is herewith submitted and made a part of this report.

Respectfully submitted by the Board of Directors.

C. H. S. MIXER,
Secretary.

REPORT OF THE DIRECTOR

OF THE

DEARBORN OBSERVATORY.

To the Board of Directors of the
Chicago Astronomical Society :

GENTLEMEN : The following brief report will exhibit the nature and amount of the astronomical work carried on at the Dearborn Observatory during the past year.

The instruments have all been kept in good working order, by making the necessary repairs and adjustments when needed.

The two standard clocks, ordered to be constructed by Howard & Co., Boston, were received during the months of June and July last. One was placed in the City Fire-Alarm office, for the use of the city in connection with the time service. And the other was mounted at the Observatory, for keeping standard time.

The fire-alarm clock has been kept as nearly correct as practicable, the error rarely exceeding two seconds from true time. During the past four months, through the courtesy of Prof. Barrett, the superintendent, the error of this clock has been telegraphed to the Observatory daily.

The automatic time signals for the city have been transmitted continuously throughout the year, with the exception of an intermission of a couple of hours last summer, when the relay at the Observatory was temporarily disabled during a thunder-storm.

The standard clock at the Observatory has maintained a satisfactory rate; but it might be made to perform still

better by inclosing it in a closet which would protect it from sudden changes of temperature.

The going of the mean-time clock has been greatly improved by increasing the driving weight from one and one-half pounds to four and one-half pounds; but in order to make it first-class, it should be re-compensated and mounted on an iron shelf.

During the year, the time signals have been usually correct within two-tenths of a second, and the accumulated error has rarely amounted to one-half second; so that our time-service will now compare favorably with the best systems elsewhere.

As heretofore, automatic time signals have been sent daily from the Observatory to the Western Union Telegraph Company's office, for distribution to the railroads and jewelers.

The Repsold meridian circle has been used on every clear day or night for time observations, for which purpose about 600 standard stars and other objects were observed on five wires, and the times of transit recorded on the chronograph.

This instrument was also used for observing the position of the great comet of 1881 on the meridian, at the lower culmination.

From June 30 to July 14, the comet was observed on nine nights for right ascension and declination.

THE EQUATORIAL.

The work with the great equatorial, as heretofore, has been mostly confined to the study of special objects and phenomena, for which great optical power, combined with good definition, is desirable.

The following objects were specially studied:

(1) The Great Comet of 1881.

(2) The planet Jupiter.

(3) The Satellites of Uranus.

(4) Difficult double stars.

THE GREAT COMET OF 1881.

Micrometer measures of the nucleus and envelope of the great comet of 1881, together with sketches showing the changes taking place from day to day, were made by Prof. Colbert and myself on eight nights, between June 23 and July 14.

These sketches showed some curious changes in the shape of the envelope about the nucleus; but no division of the nucleus, as has been alleged, was observed during this period.

If such a division really took place, it must have continued only a few hours. It seems possible, therefore, that the phenomenon in question was simply occasioned by the want of sufficient optical power to see its real character.

Prof. Colbert also made a drawing of the nucleus and envelope on June 23, showing the peculiar formation of the head and surrounding envelopes. This drawing was published in the daily "Tribune." He also made the earliest announcement of the distance of the comet from the earth.

THE PLANET JUPITER.

The various spots and markings on the planet Jupiter, as heretofore, have been carefully studied by means of micrometer measurements, accompanied by eye sketches when necessary. The work on this planet during the past three oppositions enables us to decide definitely on some points regarding the phenomena exhibited on his disc; but the actual condition of his surface cannot yet be regarded as fully ascertained. The experience, however, of the past three years has shown conclusively that direct micrometer measurement is infinitely superior to any method of estimation. In attempting to reconcile the various phenomena alleged to have been seen on his disc, the greatest difficulty exists in determining what is real and what is imaginary. Cotemporaneous sketches by different persons, or even by the same observer, show such marked discrepancies that they are of but little use in ascertaining suspected changes.

Our observations during the past three years confirm the statement heretofore made, that the changes taking place on the disc are slow and gradual; in fact, directly contrary to the doctrine taught in text-books and the history of astronomy.

It seems probable, that when the subject is more carefully studied, the phenomena seen on the disk of Jupiter will be found to be periodical, in a manner analogous to that exhibited on the surface of the Sun. It seems probable, also, that some of the markings are comparatively permanent in locality.

The hypothesis presented in last year's report, that the surface of the planet is liquid, or in a plastic condition, seems to accommodate known phenomena better than any other yet proposed.

The following is a summary of the observations on Jupiter:

GREAT RED SPOT.

Longitude	38 nights;	484	measures
Latitude	12 "	25	"
Length	13 "	39	"
Breadth	4 "	12	"
Position of major axis	3 "	12	"
Total		572	"

EQUATORIAL BELT.

Observed on twenty-four nights:

Position of the north edge	60	measures
Latitude	15	"
Width	30	"
Total	105	"

EQUATORIAL WHITE SPOTS.

Observed on thirty-two nights:

Longitude	320	measures
Latitude	18	"
Total	328	"

POLAR SPOTS, AND OTHER MARKINGS.

Observed on twenty-seven nights:

Longitude	180	measures
Latitude	60	"
Total	240	"

Being a total of 1,255 micrometer measurements.

From the micrometer measurements for longitude of spots, the equatorial diameter of the planet is deduced on fifty-six different nights, and from the latitude measures, the polar diameter on thirty nights.

The following deductions have been drawn from these observations:

ROTATION OF JUPITER.

The observations made during 1879 and 1880 showed that the great red spot was retrograding with an accelerated velocity. This drifting has continued up to the present time, and with such remarkable uniformity that the position of the spot at any future period can be very accurately computed.

The "mean" rotation period, from the observations of 1879 and 1880, was found to be $9^h\ 55^m\ 33^s.2 + 0^s.09\sqrt{t}$, in which t represents the number of days after September 25, 1879. This formula was essentially correct for the past opposition; but it was found that all the observations could be fairly represented by making the rotation period vary directly with the time, instead of the square root of the time.

The "mean" period as deduced on this hypothesis was $9^h\ 55^m\ 34^s.0 + t \times 0^s.00209$, or $9^h\ 55^m\ 35^s.9$ for the "mean" period between September 25, 1879, and March 29, 1882, comprising 916 days, or 2,214 rotations of the planet. The actual period on March 29, 1882, from the formula is $9^h\ 55^m\ 37^s.8$

From these figures it appears that the apparent rotation period has increased about four seconds since the opposition of 1879, indicating a total drift of the red spot in longitude

of 40,000 miles ; being about 10,000 for the first year, and 30,000 for the second year. These observations prove that the red spot is not the solid portion of the planet, as has been held by a number of astronomers. One of the most curious features of this interesting object is its stability. Here we have an immense floating island, 29,600 miles in length by 8,300 miles in breadth, which has maintained its shape and size, without material change, during more than three years.

The following mean results will show what probable changes have occurred. The numbers are all reduced to the mean distance of the planet from the earth:

	1879.	No. Obs.	1880.	No. Obs.	1881.	No. Obs.
Length....	12″.25	9	11″.55	20	11″.30	13
Breadth...	3″.46	8	3″.54	10	3″.66	4
Latitude ..	−6″.95	8	−7″.14	12	−7″.40	10

The position of the major axis of the spot was as follows:

		No. Obs.
1880...............	+2°.2	5
1881...............	+1°.8	3

It appears from these numbers, that between the oppositions of 1880 and 1881 the length has diminished 0″.25, or 580 miles; the breadth has increased 0″.12, or 290 miles; and that it has drifted in latitude 0″.26, or 600 miles.

The position of its major axis was essentially the same, and so far as the eye could judge the elliptical outline was the same in 1882 as in 1879. The color, also, has not materially altered. It has been recently stated by some astronomers that the spot was fading. If such be the case, I have failed to recognize the fact. On February 2, 1882, the seeing was good, when the color was found to be the same as formerly, viz, a light pink.

The color, both of the spot and belts, varies at different times, depending on the condition of the seeing. The spot and belts generally appear as a dull brick color, but on rare occasions the pink tint is very marked, especially in the red spot.

POLAR BELTS.

During the opposition of 1881 the principal polar belts were Nos. 2, 3, and 6.

The belts 2 and 3 during the past three years have remained in essentially the same latitude, as the following numbers will show:

	1879.	1880.	1881.
No. 2......	+ 9.78	+ 9.75	+ 9.11
No. 3......	+ 5.98	+ 5.89	+ 5.87

The most noticeable change has taken place in the appearance of belt No. 3. During 1879 it was not conspicuous, but it gradually increased in width and distinctness during 1880, until it reached a width of 2″.5 during the past opposition. The color, which during 1879 and 1880 was dark brown, appeared in 1881 reddish, or very similar to that of the equatorial belt.

EQUATORIAL BELT.

The great equatorial belt remained without any material change in the position of the north and south margins; but there was less dark matter between the two margins of the belt than in 1879 and 1880.

The following measurements will show what changes have taken place:

	1879.	No. Obs.	1880.	No. Obs.	1881.	No. Obs.
Latitude, north edge	+ 2″.59	10	+ 2″.33	11	+ 2″.16	7
Width............	6 .77	9	7 .04	14	6″.91	10

These numbers indicate a possible displacement in latitude of 0″.43 from 1879 to 1881.

The direction of the south edge of the belt was nearly parallel with Jupiter's equator, as given in Marth's Ephemeris. The following was the inclination observed:

	Inclination.	No. Observations.
1879..............	− 0°.01	18
1880..............	+ 0°.09	24
1881..............	+ 0°.74	20

The north edge of this belt is slightly concave.

ELLIPTICAL WHITE SPOTS.

The small, oval, white spots, a few of which made their appearance in 1880, were more numerous during the past opposition; but with the exception of two, directly south of the great red spot, they were exceedingly difficult, and could only be measured when the seeing was unusually good.

The observation of these spots has an important bearing on the rotation of different portions of the surface of the planet, as well as on its condition.

A single spot was observed on belt 3, in latitude $+ 4''.59$ and longitude $+ 4^h$, on November 1 and December 14. Unfortunately, these times differ by forty-three days, and as no other observation was secured, the whole number of rotations is in doubt. The apparent rotation period, therefore, may be $9^h\ 55^m\ 31^s.9$, or $9^h\ 49^m\ 51^s.6$; the former being the most probable.

On belt No. 6, in latitude $- 9''.6$ to $- 12''.6$, and longitude $+ 2^h.8$ to $+ 5^h.8$, no less than eight different spots were observed. They were not absolutely fixed among themselves or with reference to the great red spot, but indicated, however, a rotation period not differing greatly from that of the red spot. These results are in harmony with the observations of last year.

Two white spots, south of the great red spot, in latitude $- 9''.63$, were systematically observed during a period of three months, from November 21, 1881, to February 23, 1882.

The following figures will show the motion of these spots during the above-named period:

Date.	Difference of longitude between the following spot and the center of the great red spot.
November 22, 1881	$+\ 25^m.5$
November 24, 1881	$+\ 26^m.1$
December 1, 1881	$+\ 24^m.4$
December 6, 1881	$+\ 23^m.3$
December 23, 1881	$+\ 12^m.5$
December 28, 1881	$+\ 6^m.6$
January 9, 1882	$-\ 5^m.4$
February 4, 1882	$-\ 29^m.4$
February 23, 1882	$-\ 42^m.8$

These numbers indicate that it was at rest, relative to the red spot, from November 22 to December 6, and that subsequently it began to drift in the direction of the planet's rotation; the total drift being about 41°. During the last two months the average drift was at the rate of fifteen miles per hour.

The difference of longitude between the preceding and following white spots was as follows:

Date.	Diff. of long.
December 1, 1881	$60^m.0$
December 28, 1881	$42^m.0$
January 9, 1882	$46^m.3$
February 4, 1882	$43^m.0$
February 23, 1882	$33^m.5$

These numbers indicate that the two spots did not retain the same relative position in longitude with respect to each other.

The observations of the small white spots, during 1880 and 1881, prove that the whole surface of the planet, outside the margin of the equatorial belt, rotates with nearly the same rate. Also that these minute spots are not absolutely fixed in longitude, but may have a slow direct or retrograde motion. They are *not*, therefore, the tops of mountains, as a recent writer has suggested.

EQUATORIAL WHITE SPOTS.

The white spots which were visible between the margins of the great equatorial belt in 1879, have continued during 1880 and 1881.

There are two principal spots, differing in longitude about 15°, and in latitude about 1″.

Sometimes they are both visible, but usually only one. Occasionally a third spot is seen; the three being nearly equidistant from each other. During the past opposition, the principal spot is probably the same as that observed from October 28, 1880.

The first observation, during the past opposition, was secured on July 22, 1881, and the last on March 31, 1882, comprising a period of two hundred and fifty-two days, or more than eight months. The approximate rotation period for this spot was $9^h\ 50^m\ 09^s.8$, or the same as for the second spot observed during 1880.

These numbers indicate that the equatorial white spots drift in the direction of the planet's rotation, at the rate of two hundred and sixty miles per hour, and consequently make a complete revolution in about forty-five days.

From observations on other small white spots, as well as on dark markings near the equator, it is probable that the matter in the equatorial regions constantly drifts in the direction of the planet's rotation; and it seems probable that the rate of this drift depends on the latitude.

Some of the observations made during the past year, led us to suspect that the great equatorial belt partook of this drift-motion, but others, on the contrary, seemed to indicate that it was fixed relatively to the great red spot.

A peculiar spur, which appeared to be connected with the south margin of the equatorial belt, was seen a number of times in 1880, and its longitude, from a single measure on September 9, 1880, was $+ 19^m.0$. It was seen again on December 1, 6, etc., 1881, and its longitude was found to be $+ 24^m.4$ and $+ 23^m.3$, or essentially the same as for the previous year. If the spur is joined to the belt, then its rotation is the same as for the red spot.

From what has already been said, you will infer that the true rotation of the planet Jupiter is yet unknown. It is possible, however, that the rotation of the surface varies with the latitude in a manner analogous to that of the sun's surface.

The explanation of the phenomena seen on this planet is a problem of great difficulty, which can only be solved by persistent and continuous observation.

SATELLITES OF URANUS.

The unfavorable observing weather which we have in this climate during February and March is a great drawback in making observations on such difficult objects as the inner satellites of Uranus.

The following is a summary of the observations:

Ariel	2 nights
Umbriel	3 "
Titania	6 "
Oberon	8 "

DOUBLE STARS.

When Mr. S. W. Burnham left the Observatory to go to Madison, I began the observation of difficult double stars, more especially binary systems, as I thought it proper this kind of work should not be entirely neglected. Owing, however, to the fact that my special work has been in other directions, not very much time could be given to it. About 250 micrometer measures were made, however, including 9 of the companions of Sirius. There were also discovered about 60 difficult double stars not found in the catalogues. Among these there were two quadruple systems and one naked-eye star, with a very minute companion. They may be classified as follows:

7 less than 1″ distance.
10 from 1″ to 2″ distance.
37 from 2″ to 5″ distance.
6 over 5″ distance.

The Observatory, as usual, has been open to members of the Astronomical Society on Thursday evenings, and by special arrangement I have on a few evenings admitted classes in astronomy from the city high schools and elsewhere.

During the winter term, instruction in practical and theoretical astronomy was given to the senior class of the University.

Mr. S. W. Burnham, who was absent during the past summer at the Washburne Observatory, has returned to the city, and has resumed the observation of double stars with the great refractor. He reports:

The measurement of newly discovered double stars, and the preparation for publication of a catalogue of 151 double stars discovered here during the past three years; also a compilation of all his star observations made during the same period, comprising about 2,500 measures.

G. W. HOUGH,
Director.

CHICAGO, June, 1882.

APPENDIX A.

Historical Review of the Chicago Astronomical Society.

The Hon. J. Y. Scammon having resigned the office of President of this Society, which he has held from its organization to the present time, the Directors deem it a fit occasion for presenting a brief review of the Society's history.

In December, 1862, a movement was made, in connection with a lecture on Astronomy, to procure subscriptions for the establishment of an Astronomical Observatory in Chicago, and a committee was appointed for that purpose. A member of the committee wrote immediately to Mr. Alvan Clark of Cambidge, Mass., and learned by letter from him, dated the 19th of the same month, that he had on his hands a telescope which he had made for the University of Mississippi, but which the opening of the war had prevented that institution from taking. This glass had a clear aperture of 18½ inches and a focal length of 23 feet. The two largest achromatic telescopes in existence previous to that time were those at Harvard College, in this country, and at Pulkova, in Russia. Each of these instruments has an aperture of about 15 inches.

The efforts to raise money for the establishment of an Observatory were measurably successful, and in January, 1863, Hon. Thomas Hoyne was deputed to visit Cambridge and negotiate for the purchase of the great Clark Telescope. His arrival at Cambridge was exceedingly opportune, for he found that negotiations were going forward on the very day of his arrival for the purchase of the instrument in the interest of another Observatory. Mr. Hoyne closed a contract for its purchase without loss of time, and paid the first installment of $1,500. The whole cost of the instrument was $11,100 for the object glass, and $7,000 for the mounting.

The organization of the Chicago Astronomical Society* took place in November, 1863.

The first Board of Directors was composed of—

J. Y. Scammon,	J. H. Woodworth,
Thomas Hoyne,	J. C. Burroughs,
W. H. Wells,	J. K. Pollard,
E. B. McCagg,	T. B. Bryan.
A. H. Mixer,	

The first officers chosen were J. Y. Scammon, President, W. H. Wells and J. H. Woodworth, Vice-Presidents, Thomas Hoyne, Secretary, and D. J. Ely, Treasurer.

The purchase of a telescope made it necessary to erect a tower on which to mount it, and this required a considerably larger outlay of money than the purchase of the instrument itself. The entire expense of this important work was undertaken by a single individual, Hon. J. Y. Scammon, whose munificence had often been manifested before in connection with various public and private enterprises. Under a contract between the Chicago University and this Society, an arrangement was made for the establishment of the Observatory on the grounds of that institution. The tower was erected by Mr. Scammon on the west side of the University building, with a revolving dome about ninety feet in height. The telescope was placed in position in May, 1864.

The first Director of the Dearborn Observatory was Prof. Truman H. Safford, who had previously been engaged as assistant at the Harvard Observatory.

During the first three years, the Director devoted most of his time to the observation of nebulæ, discovering about one hundred not previously known.

In 1868, Walter S. Gurnee, of New York, formerly Mayor of Chicago, donated $5,000 to the Society for the purchase

*The early records of the Society were destroyed by the fire of 1871, and the record here given of its organization is copied from the Report of Secretary Hoyne at the meeting in April, 1874.

of a Meridian Circle, and from that time till the great fire of 1871, Prof. Safford was engaged most of the time in a series of star observations, in connection with other astronomers at the principal observatories of the world, for the great catalogue of the German Astronomical Society. The share allotted to the Dearborn Observatory was the zone between the 35th and 40th degrees of northern declination. About two-fifths of the work had been completed at the date of the fire.

In 1870, Mr. Elias Colbert was appointed Assistant Director of the Observatory, and his services were of great value to the Society, though he received no compensation for them. It was mainly through his efforts that money was raised to purchase a tower clock and place the Observatory in communication with the Court House bell.

Previous to the great fire, the salary of Prof. Safford was paid entirely by Mr. Scammon. The paralysis caused by the fire deprived Prof. Safford of his support here, and he accepted a position in another field of labor.

In 1874 the Observatory was placed in charge of Mr. Colbert, and remained in his care during the next five years. The dome had become practically useless, and Mr. Colbert raised a subscription for rebuilding it. He also made such observations as his time would allow, and revived the system of time signals that had been commenced before the fire. He arranged for furnishing time by electric communication with the Board of Trade, the Western Union Telegraph Co., the City Fire Alarm Telegraph, and a considerable number of Railroad Companies and jewelers. For these services, Mr. Colbert declined, as before, to receive any compensation.

During this period, Mr. S. W. Burnham made important use of the Observatory in prosecuting his observations upon double stars, of which notices were published in the scientific journals of this country and of Europe.

At the request of the Astronomical Society, Mr. Colbert, Superintendent of the Observatory, arranged an expedition to Denver, Colorado, for the purpose of observing the Solar Eclipse of July 29, 1878. He was accompanied in this

undertaking by Prof. G. W. Hough, Dr. Lewis Swift, of Rochester, N. Y., Mr. A. C. Thomas, of this city, and others. The observations were made with great care and exactness, and with highly satisfactory results. It was during these observations that Dr. Swift made his supposed discovery of the planet Vulcan within the orbit of Mercury.

In May, 1879, Prof. G. W. Hough, formerly Director of the Dudley Observatory, at Albany, N. Y., was elected Director of the Dearborn Observatory.

Prof. Hough brought to the Society an experience of many years in making astronomical observations, and his labors here have brought the Dearborn Observatory into special prominence among the leading observatories of the world. His observations on the planet Jupiter, in which he has been assisted by Mr. Colbert, have been recognized as a valuable contribution to Astronomical Science.

Mr. S. W. Burnham has continued the use of the Great Equatorial in his special work of double star observations.

At a recent meeting of the Directors of the Astronomical Society, the Hon. J. Y. Scammon, President of the Society, tendered his resignation, and the Directors recorded their high appreciation of his services in the following language:—

"The Hon. J. Y. Scammon having resigned the office of President of the Chicago Astronomical Society, which office he has held from the organization of the Society in 1862 to the present time, the Directors take this occasion to express their sense of obligation for his untiring interest in the success of the Dearborn Observatory, and for the munificent benefactions he has bestowed upon it.

It is to Mr. Scammon that the Society is indebted for the tower of the Observatory, which he furnished the means to erect at a cost of about $30,000.

Mr. Scammon also made a generous contribution toward the purchase of the Great Refractor, and in the early history of the Society the salary of the Director was for a considerable period paid entirely by the same liberal hand.

Whenever a history of Chicago shall be written in which justice shall be done to those who have made our city what it is, then will the name of J. Y. Scammon be found to occupy an honored place in the records of those whose benefactions have contributed most to the growth and prosperity of the city and its institutions."

APPENDIX B.

Observations on the Planet Jupiter, Made with the 18½ Inch Clark Refractor, at the Dearborn Observatory.

The following observations furnished the time of transit of the center of the great red spot, or other markings, over the meridian of ♃, perpendicular to his equator and bisecting the illuminated disc. They aim to fix with considerable precision the longitude, latitude, size and position of the various spots and markings seen on the disc.

The observations were all made with the parallel wire micrometer of the 18½ inch Clark refractor. During the opposition of 1879, a few of the early measures were referred to only *one* limb of the planet, a method not susceptible of the greatest precision, owing to the uncertain effect of irradiation, due to poor definition or other causes. In all subsequent observations, however, both limbs were used, and the measures combined in such a manner as to entirely eliminate this source of error.

For ascertaining the time of transit over the central meridian, the method of observation was as follows:

The micrometer wires were first set perpendicular to the equator of ♃ ; one wire was then made to bisect the *apparent* center of the red-spot and the other was placed tangent to the preceding limb of the planet. After two readings in this position, the times being noted to the nearest tenth of a minute, both wires were carried across the disc and one was placed tangent to the following limb and the other made to bisect the red-spot. One-half the difference of the micrometer readings, from a consecutive pair of measures, was equal to the distance of the *apparent* center of the red-spot from the central meridian, at the mean of the times.

The following example is taken from the observing note book:

February 9, 1882.

APPARENT CENTER OF RED-SPOT.

	M. T.	Prec. Limb.	M. T.	Foll. Limb.
	$7^h\ 31^m.3$	$48^{rev}.03$	$7^h\ 29^m.7$	$48^{rev}.335$
	32 .2	.02	30 .3	.325
Mean	7 31 .7	48 .025	7 30 .0	48 .330
				48 .025

$t = 7^h\ 30^m.8$

cor. for watch $+ 0\ .6$

$\Delta\ t + 9\ .3$

$T = 7\ 40\ .7$

$2\Delta = 0\ .305$

$\Delta = 0\ .152$

$\Delta = + 1''.74$

M.D. $= + 1''.67$

Usually four sets of measures similar to the above were made for longitude, but during a portion of the opposition of 1880, a much larger number were taken to ascertain whether measures made when the spot was near the limb of the planet were as reliable as when it was near the center of disc.

It appears from these observations that no appreciable error was introduced when the spot was observed within one hour of the central meridian.

As the *apparent* center of the red-spot does not coincide with the true center, except when seen on the central meridian, it is necessary to know its length and latitude, in order properly to reduce the observations.

The following constants and formulæ were used, all of which refer to the mean distance of the planet from the Earth:

CONSTANTS.

♃'s Equatorial semi-diameter	$19''.48$
" Polar " "	$18''.30$
Latitude of red-spot	$-\ 7''.14$
Logarithm D	1.2538
L	$11''.61$
V	$37^\circ.8$

These constants were derived from the observations made in 1880.

l = Observed length of spot in seconds of arc.

L = Length of the chord when on the central meridian.

V = The difference of longitude of the two ends of the spot.

D = Radius of parallel of the center of spot.

h = difference of longitude of the *apparent* center of the spot and ♃'s central meridian.

h_0 = difference of longitude of the *true* center of the spot and ♃'s central meridian.

m_0 = observed distance of the *apparent* center of the spot from ♃'s central meridian.

$\triangle t$ = time, in minutes, from the central meridian.

$$\triangle t = \frac{h_0}{0^\circ.6047} \quad \text{for the great red-spot and polar spots.}$$

$$\triangle t = \frac{h}{0^\circ.610} \quad \text{for equatorial white spot.}$$

$$D \sin (\mathrm{h}_0 - \tfrac{1}{2} V) = \mathrm{m} - \tfrac{1}{2} l.$$

$$D \sin (\mathrm{h}_0 + \tfrac{1}{2} V) = \mathrm{m} + \tfrac{1}{2} l.$$

$$L = 2 \mathrm{D} \sin \tfrac{1}{2} V.$$

$$L = \frac{l}{\cos \mathrm{h}_0}, \text{ approximately.}$$

The labor of reduction was very much shortened by forming tables of the values of h_0 and $\triangle t$ for the great red spot and equatorial white spots, with m as the argument.

For the reduction of all other spots, when the length was inappreciable, l and V were made equal to zero, and the formula was $m = D \sin h$.

D = radius of the parallel for the spot observed.

In the table of observations

t = mean of the times for a pair of measures.

m = distance from ♃'s central meridian reduced to mean distance.

$\triangle t$ = reduction to central meridian.

T = deduced time of transit over ♃'s central meridian.

R = reduction to the zero epoch, September 25, 1879. It includes the following corrections:

1. Aberration time.
2. Equinox time.
3. Annual parallax.
4. Defective illumination.

The aberration and longitude from equinox were computed for every ten days. The annual parallax and defective illumination have been derived from Marth's Ephemerides, published in the "Monthly Notices," Royal Astronomical Society.

The discussion of the observations made on 31 days, comprising 122 sets of measures, from June to December, 1880, gave for the mean error of a single pair of measures ± 0.9 minute, and for the average mean probable error for any day, ± 0.4 minute, on the observed time of transit of the center of the red spot over the central meridian.

It may be inferred from these results that the use of a micrometer is infinitely preferable to any method of estimation.

A single pair of micrometer readings, when the spot is wholly on the disc, will give a more accurate value for the time of transit over the central meridian than any system of estimation, either with or without micrometer wires. By direct measurement there is no reason to believe that there is any appreciable constant error depending on the hour angle of the planet, as Schmidt has shown to be the case for eye estimates.

GREAT RED SPOT, ♃.

Date.	t	m	Δt	T	R	Remarks.
1879	H M	"	M	H M	H M	
Sept. 25 ..	10 51.6	+ 6.23	+36.0	11 27.6	+ 00.0	One limb (2)
Oct. 5	9 38.9	+ 0.33	+ 1.8	9 40.7	+ 00.0	Observed by Prof. Colbert; one limb and end
Oct. 10 ...	8 19.7	+ 4.82	+27.6	8 47.3		One limb
"	9 26.4	− 6.04	−34.8	51.6		
			Mean	8 49.5	+ 00.3	
Oct. 14 ...	10 52.5	+11.54	+71.0	12 03.5	+ 00.4	One limb and end
Oct. 15 ...	8 01.0	− 0.33	− 1.8	7 59.2	+ 00.4	
Oct. 29 ...	8 56.2	+ 5.50	+31.6	9 27.8		
"	58.6	+ 4.76	+27.2	25.8		
"	9 24.0	+ 0.84	+ 4.7	28.7		
			Mean	9 27.4	− 00.7	
1880						
Feb. 10...	5 23.4	+ 1.18	+ 6.6	5 30.0	− 35.7	
May 6....	16 45.6	− 2.09	−11.8	16 33.8	−1 07.3	Planet low, daylight (approximate)
June 9....	14 56.8	− 2.24	−12.5	14 44.3		
"	15 10.4	− 4.92	−27.7	42.7		
			Mean	14 43.5	−1 14.1	
June 16...	15 17.6	+ 1.54	+ 8.8	15 26.4		
"	30.7	− 0.25	− 1.3	29.4		
"	34.9	− 1.08	− 6.2	28.7		
"	39.4	− 2.06	−11.6	27.8		
			Mean	15 28.1	−1 15.1	
July 3....	13 59.5	+ 4.96	+28.4	14 27.9		
"	14 06.8	+ 4.11	+23.2	30.0		
"	31.2	+ 0.02	+ 0.1	31.3		
"	15 16.6	− 7.82	−46.0	30.6		
			Mean	14 30 0	−1 16.6	
July 5....	15 33.9	+ 5.52	+31.4	16 05.3		
"	41.6	+ 4.47	+25.2	06.8		
"	58.4	+ 1.52	+ 8.5	06.9		
"	16 05.8	+ 0.10	+ 0 6	06.4		
			Mean	16 06.4	−1 16.8	
July 8....	13 44.9	− 1.53	− 8.6	13 36.3		
"	50.9	− 2.64	−14.8	36.1		
			Mean	13 36.2	−1 16.8	

Date.	t	m	△t	T	R	Remarks.
1880	H M	"	M	H M	H M	
July 15	14 08.3	+2.01	+11.2	14 19.5		
"	15.4	+0.62	+ 3.5	18.9		
"	23.1	−0.42	− 2.3	20.8		
			Mean	14 19.7	−1 16.8	
July 20	13 14.8	+1.60	+ 9.0	13 23.8		
"	21.5	+0.70	+ 3.9	25.4		
"	41.3	−2.89	−16.2	25.1		
			Mean	13 24.8	−1 16.9	
July 22	14 41.4	+3.96	+22.3	15 03.7		
"	54.4	+1.84	+10.3	04.7		
"	15 04.9	−0.21	− 1.2	03.7		
"	14.8	−2.04	−11.4	03.4		
			Mean	15 03.9	−1 16.9	
July 27	13 38.9	+5.32	+30.2	14 09.1		
"	52.6	+3.50	+19.7	12.3		
"	14 22.3	−1.84	−10.4	11.9		
			Mean	14 11.1	−1 16.7	
July 29	15 48.8	+0.21	+ 1.2	15 50.0		
"	16 03.2	−2.61	−14.6	48.6		
"	08.1	−3.31	−18.7	49.4		
			Mean	15 49.3	−1 16.6	
Aug. 3	14 41.9	+2.75	+15.4	14 57.3		
"	47.3	+1.71	+ 9.5	56.8		
"	15 01.7	−0.78	− 4.3	57.4		
			Mean	14 57.2	−1 16.3	
Aug. 5	16 07.4	+4.83	+27.3	16 34.7		
"	14.1	+3.70	+20.8	34.9		
"	19.2	+2.85	+16.0	35.2		
"	28.5	+1.33	+ 7.4	35.9		
"	46.7	−2.05	−11.4	35.3		
			Mean	16 35.2	−1 16.2	
Aug. 6	12 29.9	−0.70	− 3.9	12 26.0		
"	34.6	−1.46	− 8.2	26.4		
			Mean	12 26.2	−1 16.1	
Aug. 11	11 58.8	−4.20	−23.7	11 35.1		
"	12 10.6	−6.80	−39.1	31.5		
"	16.7	−7.14	−41.1	35.6		
			Mean	11 34.1	−1 15.6	

Date.	t	m	△t	T	R	Remarks.
1880	H M	"	M	H M	H M	
Sept. 4....	11 11.3	+0.89	+ 5.0	11 16.3		
"	15.7	−0.18	− 1.0	14 7		
"	19.4	−0.80	− 4.4	15.0	−1 11.8	
			Mean	11 15.3	−1 11.8	
Sept. 6....	12 52.5	−0.36	− 2.0	12 50.5		
"	55.9	−0.38	− 2.1	53 8		
"	13 02.0	−1.59	− 8.9	53.1		
			Mean	12 52.5	−1 11.4	
Sept. 9....	10 15.3	+0.81	+ 4.5	10 19.8		
"	18.9	+0.20	+ 1.1	20.0		
"	21.8	−0.09	− 0.5	21.3		
"	25.8	−0.35	− 1.9	23.9		
			Mean	10 21.2	−1 10.7	
Sept. 21...	9 55.6	+2.16	+12.1	10 07.7		
"	59.7	+1.58	+ 8.8	08.6		
"	10 05.7	+1.00	+ 5.5	11.2		
"	11.4	+0.22	+ 1.3	12.7		
			Mean	10 10.0	−1 08.2	
Sept. 28...	10 02.3	+9.05	+53.3	10 55.6		
"	06.4	+8.08	+47.1	53.5		
"	16.9	+6.09	+34.7	51.6		
"	22.4	+5.78	+33.0	55.4		
"	32.7	+3.44	+19 4	52.1		
"	38.1	+2.85	+16.0	54.1		
"	53.9	+0.22	+ 1.3	55.2		
			Mean	10 53.9	−1 06.5	
Oct. 1.....	8 22.7	+0.48	+ 2.7	8 25.4		
"	27.7	−0.43	− 2.4	25.3		
"	49.0	−4.49	−24.8	24.2		
			Mean	8 25.0	−1 05.9	
Oct 5.....	11 13.2	+4.56	+25.8	11 39.0		
"	17.2	+3.66	+20.7	37.9		
"	25.7	+2.42	+13.6	39.3		
"	31.5	+0.88	+ 4.9	36.4		
			Mean	11 38.1	−1 05.0	

Date.	t	m	△t	T	R	Remarks.
1880	H M	"	M	H M	H M	
Oct. 13....	7 46.9	+4.69	+26.6	8 13.5		
"	51.7	+3.26	+18.4	10.1		
"	56.4	+2.91	+16.3	12.7		
"	8 00.8	+1.99	+11.1	11.9		
"	09.8	+0.10	+ 0.6	10.4		
"	14.5	−0.73	− 4.1	10.4		
			Mean	8 11.5	−1 03.3	
Oct. 23....	7 04.7	−6.63	−38.0	6 26 7		
"	08.3	−6.90	−39.7	28.6		
"	13.2	−7.88	−46.4	26.8		
"	16.9	−8.76	−51.4	25.5		
			Mean	6 26.9	−1 01.6	
Nov. 1....	8 23.6	+3.99	+22.5	8 46.1		
"	28.8	+2.99	+16.8	45.6		
"	42.1	+0.28	+ 1.5	43.6		
"	9 19.8	−5.89	−33.6	45.2		
"	23.7	−6.59	−37.8	45.9		
			Mean	8 45.3	−1 00.5	
Nov. 13 ..	8 19.1	+3.41	+19.2	8 38.3		
"	23.0	+2.52	+14.1	37.1		
"	27.0	+1.96	+10.9	37.9		
"	31.1	+1.28	+ 7.1	38.2		
			Mean	8 37.9	−1 00.0	
Nov. 16...	6 06.7	+0.25	+ 1.4	6 08.1		
"	11.0	−0.81	− 4.5	06.5		
"	16.5	−1.82	−10.1	06.4		
"	21.0	−2.35	−13.2	07.8		
			Mean	6 07.2	−1 00.1	
Nov. 26...	4 44.0	−3.72	−20.9	4 23.1		
"	47.7	−4.27	−24.1	23.6		
"	51.1	−4.93	−27.9	23.2		
"	55.0	−5.58	−31.8	23.2		
			Mean	4 23.3	−1 00.5	
Dec. 3....	4 56.9	+2.05	+11.5	5 08.4		
"	5 10.0	−0.25	− 1.4	08.6		
"	13.7	−1.06	− 5.8	07.9		
"	24.5	−2.97	−16.7	07.8		
"	28.3	−3.55	−20.0	08.3		
			Mean	5 08.2	−1 01.2	

Date.	t	m	△ t	T	R	Remarks.
1880	H M	"	M	H M	H M	
Dec. 8....	4 40.5	−4.10	−23.1	4 17.4		
"	43.6	−4.85	−27.5	16.1		
"	46.3	−4.94	−28.0	18.3		
"	48.7	−5.56	−31.7	17.0		
"	51.6	−5.81	−33.1	18.5		
"	55.3	−6.36	−36.4	18.9		
"	59.2	−7.32	−42.2	17.0		
			Mean	4 17.6	−1 01.9	
Dec. 10...	5 52.2	+0.42	+ 2.4	5 54.6		
"	55.0	−0.30	− 1.6	53.4		
"	58.2	−0.76	− 4.2	54.0		
"	6 01.3	−0.35	− 1.9	59.4		
			Mean	5 55.3	−1 02.1	
Dec. 12...	6 51.3	+7.86	+46.2	7 37.5		
"	55.2	+6.54	+37.5	32.7		
"	7 01.1	+5.91	+33.8	34.9		
"	07.2	+4.40	+24.8	32.0		
"	12.1	+3.92	+22.1	34.2		
"	16.4	+2.97	+16.7	33.1		
			Mean	7 34.1	−1 02.5	
Dec. 27...	5 07.2	−1.28	− 7.2	5 00.0	−1 06.0	Approximate,seeing too poor.
Dec. 31...	8 12.7	+0.29	+ 1.6	8 14.3		
"	16.0	+0.34	+ 1.9	17.9		
"	27.3	−1.72	− 9.6	17.7		
"	31.8	−2.36	−13.2	18.6		
			Mean	8 17.1	−1 06.8	
1881						
Jan. 10...	7 05.7	−5.39	−30.7	6 35.0		
"	08.5	−5.77	−32.9	35.6		
			Mean	6 35.3	−1 10.0	
Jan. 17...	7 25.6	−1.06	− 5.8	7 19.8		
"	30.8	−1.80	−10.0	20.8		
"	34.3	−2.43	−13.6	20.7		
"	37.3	−2.93	−16.4	20.9		
			Mean	7 20.5	−1 12.2	
Jan. 27...	5 46.0	−0.60	− 3.4	5 42.6		
"	50.4	−1.50	− 8.4	42.0		
"	54.7	−2.02	−11.3	43.4		
"	57.2	−2.73	−15.3	41.9		
			Mean	5 42.5	−1 16.1	

Date.	t	m	Δt	T	R	Remarks.
1881	H M	"	M	H M	H M	
June 17 ..	16 49.8	+6.63	+38.0	17 27.9		
"	55.8	+5.45	+31.0	26.8		
			Mean	17 27.3	−2 09.8	
June 20 ..	15 26.0	−5.21	−29.6	14 56.4		
"	31.5	−5.43	−30.9	15 00 1		
			Mean	14 58.2	−2 10.4	
June 22 ..	16 42.2	−0.81	− 4.5	16 37.7		
"	46.1	−1.82	−10.4	35.7		
			Mean	16 36.7	−2 10.9	
July 28..	15 46.5	+6.25	+35.7	16.22.2		
"	52.1	+4.70	+26.6	18.7		
"	59.9	+3.17	+17.8	17.7		
"	16 26.1	−1.22	− 6.8	19.3		
			Mean	16 19.5	−2 16.9	
Aug. 2....	15 26.3	+0.15	+ 0.8	15 27.1		
"	30.7	−0 51	− 2.8	27.9		
"	38.7	−1.92	−10.7	28.0		
			Mean	15 27.7	−2 17.3	
Aug. 9....	16 01.2	+2.35	+13.2	16 14.4		
"	06.6	+1.34	+ 7.5	14.1		
"	12.6	−0.04	− 0.2	12.4		
"	16.6	−0.78	− 4.4	12.2		
			Mean	16 13.3	−2 17.8	
Aug. 24...	13 38.5	+0.39	+ 2.2	13 40.7		
"	45.2	−0.78	− 4.3	40.9		
"	14 09.8	−5.80	−33.1	36.4		
			Mean	13 39.3	−2 18.0	
Sept. 5 ...	13 34.1	−0.94	− 5.2	13 28.9	−2 17.7	Clouded, poor seeing.
Sept. 21 ..	16 31.6	+1.02	+ 5.7	16 37.3		
"	36.7	−0.26	− 1.4	35.3		
"	41.1	−0.93	− 5.2	35.9		
"	45.4	−1.38	− 7.7	37.7		
			Mean	16 36.5	−2 16.1	
Sept. 22 ..	12 17.3	+1.69	+ 9.4	12 26.7		
"	22.4	+0.73	+ 4.1	26.5		Clouded up.
			Mean	12 26.6	−2 16.0	

Date.	t	m	Δt	T	R	Remarks.
1881	H M	''	M	H M	H M	
Oct. 7	9 00.5	+8.41	+49.2	9 49.7		
"	04.6	+7.36	+42.5	47.1		
"	08.2	+6.59	+37.8	46.0		
"	11.7	+6.07	+34.6	46.3		
			Mean	9 47.3	−2 13.6	
Oct. 9	11 18.3	+1.17	+ 6 5	11 24.8		
"	23.7	−0.02	− 0.1	23.6		
"	30.9	−0.86	− 4.8	26.1		
"	34.0	−1.61	− 9.0	25.0		
			Mean	11 25.0	−2 13.2	
Oct. 24 ...	9 02.3	−3.17	−17.8	8 44.5		
"	06.2	−4.15	−23.4	42.8		
"	10.5	−4.50	−25.4	45.1		
"	15.1	−5.85	−30.4	44.7		
			Mean	8 44.3	−2 10.1	
Oct. 26 ...	9 39.4	+7 22	+41.6	10 21.0		
"	44.0	+6.09	+34.7	18.7		
"	48.0	+5.72	+32.6	20.6		
"	51.9	+5.09	+28.9	20.8		
			Mean	10 20.3	−2 09.7	
Nov. 5....	8 19.0	+2.26	+12.6	8 31.6		
"	26.6	+1.46	+ 8.1	34.7		
"	31.0	+0.58	+ 3.2	34.2		
			Mean	8 33.5	−2 07.3	
Nov. 9....	11 20.6	+5.33	+30.3	11 50.9		
"	25.5	+4.35	+24.6	50.1		
"	38.0	+2.26	+12.6	50.6		
"	41.4	+1.95	+10.9	52.3		
			Mean	11 51.0	−2 06.4	
Nov. 19...	9 29.1	+5.95	+33.9	10 03.0		
"	34.6	+5.11	+29.0	03.6		
"	40.4	+3.97	+22.4	02.8		
"	45.7	+3.31	+18.6	04.3		
			Mean	10 03.4	−2 04.4	
Nov. 21...	11 43.0	−0.55	− 3.1	11 39.9		
"	46.5	−1.19	− 6.6	39.9		
			Mean	11 39.9	−2 04.0	

Date.	t	m	△t	T	E	Remarks.
1881	H M	"	M	H M	H M	
Nov. 22...	7 02.6	+5.48	+31.2	7 33.8		
"	05.9	+4.56	+25.8	31.7		
"	09.4	+4.13	+23.3	32.7		
"	13.3	+3.54	+20.0	33.3		
			Mean	7 32.9	−2 03.8	
Nov. 24...	8 36.0	+5.63	+32.1	9 08.1		
"	39.2	+5.78	+33.0	12.2		
"	42.6	+4.93	+27.9	10.5		
"	46.3	+4.17	+23.5	09.8		
			Mean	9 09.1	−2 03.5	
Dec. 1....	9 36.0	+3.50	+19.7	9 55.7		
"	39.4	+3.00	+16.8	56.2		
"	43.2	+2.05	+11.5	54.7		
"	47.0	+1.62	+ 9.0	56.0		
			Mean	9 55.6	−2 02.5	
Dec. 4....	7 39.4	−2.76	−15.4	7 24.0		
"	42.4	−3.24	−18.2	24.2		Obs. stopped by clouds; one limb
			Mean	7 24.1	−2 02.0	
Dec. 6....	8 55.5	+1.17	+ 6.5	9 02.0		
"	9 00.1	+0.48	+ 2.6	02.7		
			Mean	9 02.3	−2 01.7	
Dec. 14...	5 57.7	−3.44	−19.3	5 38.4		
"	6 00.9	−3.62	−20.4	40.6		
"	05.8	−5.02	−28.5	37.3		
"	10.1	−5.74	−32.7	37.4		
			Mean	5 38.4	−2 01.2	
Dec. 18...	8 37.2	+3.41	+19.2	8 56.4		
"	41.8	+2.19	+12.3	54.1		
"	47.2	+1.00	+ 5.6	52.8		
			Mean	8 54.4	−2 01.0	
Dec. 23...	8 04.9	−0.62	− 3.5	8 01.4		
"	08.7	−1 57	− 8.7	00.0		
			Mean	8 00.7	−2 01.0	
Dec. 28...	6 56.4	+2.48	+13.9	7 10.3		
"	7 00.1	+1.20	+ 6.7	06.8		
"	17.8	−1.91	−10.6	07 1		
"	21.8	−2.26	−12.6	09.2		
			Mean	7 08.3	−2 01.2	

Date.	*t*	*m*	△*t*	*T*	*R*	Remarks.
1882	H M	"	M	H M	H M	
Jan. 9....	6 57.6	+0.00	+ 0.0	6 57.6		
"	7 01.0	−0.30	− 1.7	59.3		
"	04.9	−0.80	− 4.5	60.4		
"	11.0	−2.22	−12.4	58.6		
			Mean	6 59.0	−2 02.3	
Jan. 11...	8 01.5	+6.25	+35.7	8 37.2		
"	07 3	+5.51	+31.4	38.7		
"	12.5	+4.27	+24.1	36.6		
"	17.0	+3.99	+22.5	39.5		
			Mean	8 38.0	−2 02.6	
Jan. 14...	5 57.1	+1.80	+10 0	6 07.1		
"	6 00.7	+1.84	+10.2	10.9		
"	06.4	+0.31	+ 1.7	08.1		
			Mean	6 08.7	−2 03.0	
Feb. 2....	6 31.7	+3.26	+18.3	6 50.0		
"	34.9	+2.39	+13.4	48.3		
"	38.3	+1.91	+10.8	49.1		
"	41.5	+1.28	+ 7.1	48.6		
			Mean	6 49.0	−2 07.2	
Feb. 4....	7 59.6	+5.70	+32.5	8 32.1		
"	8 03.2	+4.96	+28.1	31.3		
"	09.5	+4.14	+23.4	32.9		
"	12.8	+3.17	+17.8	30.6		
			Mean	8 31.7	−2 07.7	
Feb. 7 ...	6 02.4	+0.18	+ 1.0	6 03.4		Cloudy.
"	07.7	−1.16	− 6 4	01.3		
			Mean	6 02.4	−2 08.6	
Feb. 9....	7 28.5	+2.28	+12.7	7 41.2		
"	31.4	+1 67	+ 9.3	40.7		
"	39.0	+0.28	+ 1.4	40.4		
"	42.2	−0.35	− 2.0	40.2		
			Mean	7 40.6	−2 09.2	
Feb. 14...	6 38.0	+2.78	+15.6	6 53.6		Very poor seeing, high wind.
"	41.5	+1.43	+ 8.0	49.5		
"	47.5	+0.13	+ 0.8	48.3		
"	51.1	+0.12	+ 0.8	51.9		
			Mean	6 50.8	−2 10.6	
Feb. 23...	8 29.1	+8.22	+47.9	9 17.0	−2 13.6	

Date.	t	m	△t	T	R	Remarks.
1882	H M	″	M	H M	H M	
March 22.	6 39.0	+ 0.98	+ 5.5	6 44.5		
"	42.3	+ 0.19	+ 1.1	43.4		
"	7 09.8	− 4.64	−26.3	43.5		
			Mean	6 43.8	−2 24.0	
March 29.	7 11.3	+ 3.31	+18.6	7 29.9		
"	18 3	+ 2.05	+11.4	29.7		
			Mean	7 29.8	−2 26.8	

EQUATORIAL WHITE SPOTS ON ♃.

Date.	t	m	△t	T	R	Remarks.
1879	H M	″	M	H M	H M	
Sept. 10...	11 16.0	+13.19	+71.2	12 27.2	− 2.4	Foll. limb, Lat. obs., −2″.40
Sept. 20...	9 33.5	−13.46	−73.0	8 20.5	− 0.8	Prec. limb, Lat. obs., −2″.03
1880.						
July 8....	14 19.3	− 9.23	−47.2	13 32.1	−1 16.8	Lat. obs., −1″.92
July 17...	14 52.0	−11.18	−58.5	13 53.5	−1 16.8	
July 24...	13 10.6	− 1.29	− 6.3	13 04.3		Lat. obs., −2″.53
"	17.4	− 2.66	−13.1	04.3		Second spot following.
"	25.9	− 4.36	−21.6	04.3		Diff. long. obs., 25.0 min.
			Mean	13 04.3	−1 16.9	
Aug. 4....	14 22.9	+ 1.86	+ 9.1	14 32.0		
"	35.8	− 0.34	− 1.7	34.1		
"	40.2	− 1.19	− 5.9	34.3		
			Mean	14 33.5	−1.16.3	
Aug. 6....	15 19.8	+ 4.11	+20.3	15 40.1		
"	31.2	+ 2.18	+ 9.1	40.3		
"	35.2	+ 1.07	+ 5.2	40.4		
			Mean	15 40.3	−1 16.0	
Aug. 11...	13 17.1	+ 5.20	+25.8	13 42.9		
"	24.1	+ 3.77	+18.6	42.7		
"	30.8	+ 2.56	+12.6	43.4		
"	35.8	+ 0.84	+ 4.1	39.9		
			Mean	13 42.2	−1 15.6	

Date.	t	m	Δt	T	R	Remarks.
1880	H M	"	M	H M	H M	
Sept. 3....	12 03.6	+3.37	+16.6	12 20.2		
"	07.2	+2.22	+11.0	18.2		
"	13.7	+0.90	+ 4.5	18.2		
"	17.2	+0.36	+ 1.8	19.0		
			Mean	12 18 9	−1 12.0	
Sept. 10.	10 52.9	+6.68	+33.4	11 26.3		
"	57.4	+6.31	+31.5	28.9		
"	11 06.7	+4.16	+20.6	27.3		
"	11.8	+2.88	+14.1	25.9		
			Mean	11 27.1	−1 10.6	
Sept. 24...	9 58.3	−3.07	−15.1	9 43.2		Lat. observed, −2''.96, from S. Pole only
"	10 02.5	−3.81	−18.8	43.7		
"	08.4	−5.20	−25.8	42.6		
"	18.5	−7.16	−35.9	42.6		
			Mean	9 43.0	−1 07 4	
Oct. 1.....	8 24.9	+5.49	+27.2	8 52.1*		* Difference of Long. from the Red Spot
"	54.8	+0.13	+ 0.6	55.4		
"	58.2	−1.06	− 5.2	53.0		
			Mean	8 53.5	−1 05.9	
Oct. 28....	10 26.2	−1.94	− 9.5	10 16.7		Lat obs., −2''.80
"	34.1	−2.75	−13.5	20.6		
"	38.6	−3.52	−17.5	21.1		
			Mean	10 19.5	−1 01.0	
Nov. 2....	7 35.9	+8.67	+44.1	8 20.0		White Spot prec.—59.2 min.
"	43.4	+7.47	+37.5	20.9		
"	53.4	+5.60	+27.9	21.3		White Spot prec. and north—18.1 min.
			Mean	8 20.7	−1 00.4	
Nov. 8....	11 31.1	+4.98	+24.5	11 55.6		White Spot prec.—18.5 min.
"	35.5	+3.36	+16.5	52.0		White spot foll.—22.6 min.
			Mean	11 53.8	−1 00.1	
Dec. 2....	5 50.1	+6.60	+33.0	6.23.1		Lat. observed—−2''.95, from South pole only.
"	5 54.0	+5.41	+26.9	20.9		
"	6 03.5	+3.49	+17.2	20.7		
"	10.3	+2.34	+11 5	21.8		
"	20.0	+0.21	+ 1.0	21.0		
			Mean	6 21.5	−1 01.1	

Date.	t	m	△t	T	R	Remarks.
1880	H M	″	M	H M	H M	
Dec. 6....	8 25.2	+ 5.17	+25.6	8 50.8		
"	29.3	+ 4.50	+22.2	51.5		
"	32.8	+ 3.92	+19.3	52.1		
"	36.3	+ 3.10	+15.2	51.5		
"	42.6	+ 1.97	+ 9.5	52.1		
			Mean	8 51.6	−1 01.6	
Dec. 9....	5 07.2	+ 7.04	+35.3	5 42.5		Approximate diameter of white spot, 1″.37
"	11.4	+ 6.02	+30.0	41.4		M. D. 1″.19
"	16.2	+ 5.46	+27.1	43.3		
"	22.1	+ 4.25	+21.0	43.1		
"	26.2	+ 3.13	+15.5	41.7		
			Mean	5 42.4	−1 02.0	
Dec. 31...	8 19.5	+ 6.39	+31.9	8 51.4		
"	22.7	+ 5.64	+28.0	50.7		
			Mean	8 51.1	−1 06.9	
Jan. 30...	6 44.6	+ 3.68	+18.1	7 02.7		Spot not conspicuous, seeing good.
"	48.0	+ 2.58	+12.6	00.6		
"	52.3	+ 1.93	+ 9.5	01.8		
			Mean	7 01.7	−1 17.2	
July 22...	16 14.0	+ 2.00	+10.0	16 24.0	−2 16.2	White spot prec. △ *m.*, 5″.56 △ *t.*, 27.5 min.
Aug. 9....	16 33.0	+ 2.59	+12.7	16 45.7	−2 17.8	Prec. end of rift.
Sept. 1....	14 46.7	+10.55	+54.6	15 41.3	−2 17.9	Very poor seeing, single measure.
Sept. 21...	16 59.2	+ 6.80	+34.0	17 33.2		Prec. end of rift.
"	17 03.5	+ 5.86	+29.2	32.7		Lat. obs., 3″.77
			Mean	17 33.0	−2 16.1	
Oct. 8	12 02.5	+11.48	+60.2	13 02.7		Foll. spot.
"	07.8	+10.10	+52.2	00.0		Lat. obs., 2″.85
"	12.4	+ 9.37	+48.0	00.4		Prec. spot not measured.
"	19.4	+ 8.13	+41.1	00.5		
			Mean	13 00.9	−2 13.4	
Oct. 18 ...	9 36.8	− 7.87	−39.8	8 57.0		
"	40.4	− 8.19	−41.5	58.9		
			Mean	8 58.0	−2 11.4	

Date.	t	m	△t	T	R	Remarks.
1881	H M	"	M	H M	H M	
Oct. 20 ...	9 45.0	+ 4.68	+23.1	10 08.1		
"	49.1	+ 3.72	+18.3	07.4		
"	56.9	+ 1.79	+ 8.8	05.7		
"	10 03.6	+ 0.89	+ 4.3	07.9		
			Mean	10 07.3	−2 11.0	
Nov. 5....	8 36.4	+11.15	+58.2	9 34.6	−2 07.3	Clouded up
Nov. 9....	11 30.3	+ 4.68	+23.1	11 53.4		
"	33.3	+ 4.29	+21.2	54.5		
"	45.9	+ 1.69	+ 8.3	54.2		
"	49.3	+ 1.02	+ 5.0	54.3		
			Mean	11 54.1	−2 06.4	
Nov. 14...	9 22.7	+ 5.98	+29.8	9 52.5		Single reading
"	27.9	+ 6.40	+32.0	59.9		
			Mean	9 56.2	−2 05.3	
Nov. 21...	9 05.5	+ 1.63	+ 8.0	9 13.5		End of rift not sharply defined
"	09.4	+ 0.75	+ 3.6	13.0		
"	12.7	+ 0.01	+ 0.0	12.7		
"	15.7	− 0.32	− 1.6	14.1		
			Mean	9 13.3	−2 04.0	
Nov. 24...	6 43.3	− 7.33	−36.9	6 06.4		End of long rift
"	47.2	− 7.93	−40.0	07.2		
			Mean	6 06.8	−2 03.5	
Nov. 26...	7 09.2	+ 1.90	+ 9.4	7 18.6		White spot foll.
"	12.5	+ 0 92	+ 4.5	17.0		Δt=27.5 min.
"	15.4	+ 0.19	+ 1.0	16.4		Lat. obs. foll. spot, −2″.57
"	18.3	− 0.08	− 0.4	17.9		Lat. obs. prec. spot, −3″.10
			Mean	7 17.5	−2 03.1	
Dec. 7....	8 22.0	+ 4.32	+21.3	8 43.3		Lat. obs., −2″.97
"	25.1	+ 3.55	+17.5	42.6		
"	29.5	+ 2.66	+13.1	42.6		
"	32.8	+ 2.38	+11.7	44.5		
			Mean	8 43.2	−2 01.7	
Dec. 9....	9 46.6	+ 1.05	+ 5.1	9 51.7		
"	49.5	+ 0.60	+ 3.0	52.5		
			Mean	9 52.1	−2 01.4	

Date.	t	m	△t	T	R	Remarks.
1881	H M	"	M	H M	H M	
Dec. 10...	5 32.8	− 0.21	− 1.0	5 31.8		Lat. obs.—3".41. White Spot foll. △t.= +23.0 min. Not well defined.
"	35.1	− 0.59	− 2.8	32.3		
"	37.9	− 0.96	− 4.7	33.2		
"	40.2	− 1.47	− 7.3	32.9		
			Mean	5 32.5	—2 01.4	
Dec. 14...	7 46.3	+ 1.20	+ 5.9	7 52.2		
"	48.9	+ 0.83	+ 4.0	52.9		
"	52.0	+ 0.34	+ 1.6	53.6		
"	55.1	− 0.25	− 1 3	53.8		
			Mean	7 53.1	—2 01.1	
Dec. 23...	8 11.8	+ 0.53	+ 2.6	8 14.4		
"	15.6	− 0.74	− 3.6	12.0		
			Mean	8 13.2	—2 01.0	
Dec. 28...	6 39.0	− 4.85	−24.0	6 15.0		
"	42.5	− 5.50	−27.4	15.1		
			Mean	6 15.0	—2 01.2	
1882. Jan. 17....	7 55.9	+ 4.73	+23.4	8 19.3		
"	59.7	+ 3.98	+19.6	19.3		
"	8 02.3	+ 3.51	+17.3	19.6		
"	04.8	+ 2.85	+14.0	18.8		
			Mean	8 19.3	—2 03 6	
Jan. 22....	6 29.2	− 2.39	−11.7	6 17.5		
"	32.7	− 2.86	−14.0	18.7		
"	43.3	− 4.81	−23.8	19.5		
			Mean	6 18.6	—2 04.6	
Jan. 24...	7 38.6	− 1.98	− 9.7	7 28.9		White Spot prec. 20.1 min
"	41.3	− 2.50	−12.3	29.0		White Spot foll.;
			Mean	7 29.0	—2 05.0	the foll. end of rift, 25.7 min.
Jan. 29...	5 32.7	− 3.29	−16.2	5 16 5		White Spot foll.
"	35.4	− 3.75	−18.5	16.9		△t= +23.0 min. Not well outlined.
			Mean	5 16.7	—2 05.9	Foll. Spot is the standard one.
Feb. 2....	7 04.1	+10.68	+55.4	7 59.5		
"	08.8	+ 9.75	+50 0	58.8		
"	12.8	+ 8.95	+45.6	58.4		
			Mean	7 58.9	—2 07.2	

Date.	t	m	Δt	T	R	Remarks.
1882	H M	"	M	H M	H M	
			+34.4			
Feb. 4....	8 21.3	+ 6.69	+10.4	9 06.1	—2 07.6	Diff. Long. from Red Spot. Spot is the end of a rift.
Feb. 7....	6 11.7	− 2.27	−11.1	6 00.6		
"	14 4	− 2.77	−13.6	00.8		
			Mean	6 00.7	—2 08.6	
Feb. 9....	6 49.7	+ 4.02	+19.9	7 09.6		Foll. White Spot nearer the Equator.
"	7 03.1	+ 1.96	+ 9.6	12.7		Δt=23.5 min.
"	06.8	+ 0 60	+ 3.0	09.8		
			Mean	7 10.7	—2 09.1	
Feb. 16...	6 36.0	+ 0.49	+ 2.4	6 38.4		
"	40.9	− 1.23	− 6.0	34.9		
"	44.8	− 1.47	− 7.2	37.3		
			Mean	6 36.9	—2 11.3	
March 1..	8 18.4	+11.20	+58.6	9 17.0		Poor seeing, very difficult.
"	25.8	+ 9.66	+49.6	15.4		
			Mean	9 16.2	—2 15.8	
March 22.	6 43.8	+ 2.68	+13.2	6 57.0	—2 24.0	Diff. Long. from R Spot.
March 31.	7 05.1	+ 4.59	+22.7	7 27.8	—2 27.7	

Small Black Spot on Belt No. 2.

Date.	t	m	Δt	T	Long. from Red Spot	Remarks.
1880	H M	"	M	H M	H M	
Aug. 5....				16 35	+ 0.0	Nearly long. of red spot estimated.
Sept. 4....				11 15	+ 0.0	Estimated.
Sept. 9....		−0.52		10 18.3	− 2.9	Referred to red spot.
Oct. 1.....		−1.58		8 15.7	− 9.3	Referred to red spot.

Small Black Spot on Belt No. 2.

Sept. 4....	13 29.1		+ 8.0	13 37.1	+2 21.8	
Sept. 9....	12 12.8	+4.92	+29.2	12 42.0	+2 20.8	
Oct 6.....	10 28.2	−5.07	−30.3	9 57.9	+2 28.7	Difficult. Lat. obs. +9".66.

Black Spot on Belt No. 3.

Nov. 26...	5 31.1	+5.46	+28.6	6 01.7		Lat. obs., +5".99. Well defined and black.
"	38.2	+4.38	+22.8	01.0		
"	41.5	+3.82	+19.8	01.3		
"	44.7	+3.33	+17.2	01.9		
			Mean	6 01.5	+1 38.2	
Dec. 3....		+1.16	+ 6.4	5 14.6	+ 6.4	

On December 3, the spot observed, was preceded and followed by ill-defined patches on this belt. If the objects observed on November 26 and December 3 are identical, the motion is the same as for the equatorial white spots, viz: a period of $9^h\ 50^m\ 08^s.5$.

Oval White Spot on Belt No. 2.

Aug. 4...	13 45.4	−0.40	− 2.4	13 43.0	+2 54.7	Lat. obs., +10".46.
Aug. 6...	15 09.7	+2.69	+15.9	15 25.6	+2 59.4	Very faint.
Aug. 26...	12 21.3	−4.99	−29.7	11 51.6	+3 00.7	Cloudy.
Sept. 4....	14 01.1		+14.2	14 15.3	+3 00.0	Not very distinct.
Oct. 6	10 40.3	−0.13	− 1.0	10 39.3	+3 10.0	Very hard to see.

Black Spot on Belt No. 2.

Aug. 4....	15 00.9	+1.47	+ 8.8	15 09.7		Assumed lat., +10".0.
"	07.0	+0.46	+ 2.7	09.7		
			Mean	15 09.7	+4 21.4	Spot entirely black; about 1" in width and 2" in length.
Aug. 6....	16 18.0	+4.83	+28.8	16 46.8		
"	27.7	+3.67	+21.7	49.4		
			Mean	16 48.1	+4 21.9	

OVAL WHITE SPOTS ON BELT NO. 6.

Date.	t	m	Δt	T	Long. from Red Spot	Remarks.
1880	H M	"	M	H M	H M	
Aug. 4 ...	14 26.2	+3.34	+21.4	14 47.6	+3 59.3	Lat. obs—11".62.
"	14 30.9	+6.38	+41.9	15 12.8	+4 24 5	Foll. spot. Spots about 0".5 in diam.
Aug. 6....	16 06 3	+2.64	+16.9	16 23.2	+3 57.3	
"	diff.lon.	+4.38	+29.3	16 52.5	+4 26 6	Foll. spot.
Oct. 6	11 08.6	+1.65	+10.5	11 19.1		Another white spot, north and between (1) and (2).
"	16.9	−0.08	− 0.5	16.4		
"	35.3	−2.52	−16.0	19.3		
			Mean	11 18.3	+3 48.9	
	diff.lon.	+5.12	+33.1	11 51.4	+4 22.0	Foll. spot.

OVAL WHITE SPOTS ON BELT NO. 6.

These spots were about one-second of arc in length, and at all times were very difficult to see. They were only visible when the seeing was good.

Date.	T	Name.	Long. from Red Spot.	Remarks.
1881	H M		H M	
Oct. 10	10 03.4	*a*	+2 47.4	Lat. obs.—12".60.
"	10 13.0	*b*	+2 57.0	Lat. obs.—9".59.
"	10 36.5	*c*	+3 20.5	Lat. (est)—9".6.
Dec. 24.......	7 38.7	*a*	+3 44.7	
"	7 51.9	*b*	+3 59.0	
"	8 11.0	*c*	+4 18.0	
1882				
Jan. 17		*a*	+3 29.8	
"	7 13.5	*b*	+3 35.8	Lat. obs.—10".00.
"		*c*	+3 52.0	
1881				
Sept. 9	11 58.2	*f*	+5 09.1	Lat. obs.—10".78.
Oct. 10	11 16.6	*d*	+4 00.6	Lat. obs.—10".00.
"	11 57.6	*e*	+4 41.6	Lat. (est)—9" 6.
Oct. 20	9 24.3	*d*	+3 55.7	
"	10 11.5	*e*	+4 42.9	
Oct. 25	9 08.2	*e*	+4 32.8	Lat. obs.—10".29.
"	9 52.9	*f*	+5 17.5	Lat. obs.—11".49.
"	10 08.6	*g*	+5 33.2	Lat. obs.—10".29.
"	10 28 0	*h*	+5 52.6	Lat. (est)—11".5.
Nov. 21	6 52.0	*f*	+5 07.7	
Dec. 7........	7 25.1		+2 32.1	Lat. obs.—9".83.
Dec. 10.......	7 17 est		+4 55.0	Lat. obs.—11".51.
"	7 18.5		+4 56.4	Lat. obs.—10".24.
"	8 07 est		+5 45.0	Lat. (est)—11".5.
1882				
Jan. 17			+2 23.5	
"	6 26.9		+2 48.0	

Small White Spot on South Margin of Equatorial Belt.

Date.	t	m	Δt	T	*Long. fr. Eq. w. spot*	Remarks.
1881	H M	"	M	H M	H M	
Oct. 25....	10 21.4	− 0.10	− 0.5	10 20.9	+2 11.9	
Nov. 24...	8 21.9	− 0.89	− 4.3	8 17.6	+2 08.9	
Dec. 10...	7 33.3	− 0.87	− 4.3	7 29.0	+1 56.5	
1882						
Jan. 11....	6 49.0	− 7.79	−39.3	6 09.7	+1 26.0	Probably the second spot obs. March 2.
March 2..	7 39.3	− 8.63	−43.8	6 55.5	+1 59.0	Two small spots.
March 2..		− 4.19	−24.9	6 30.6	+1 34.1	

The spot observed from October 25 to January 11 is presumed to be the same object. It was very minute and could only be fairly seen with a power of at least 400. The rotation period is about seventeen seconds shorter than for the Equatorial white spot, but the motion is not uniform, as may be inferred from the numbers in the sixth column.

Cloudy Patch in the Equatorial Belt.

Date.	T	*Long. from Eq. white spot*	Date.	T	*Long. from Eq. white spot*
1881	H M	H M	1881	H M	H M
Oct. 18......	8 18.3	+0 56.0	Nov. 26.....	9 54.1	+0 60.8
Oct. 20......	9 06.1	+0 50.5	Dec. 14.....	10 57.8	+1 13.0
Nov. 24.....	7 51.6	+0 44.9	Dec. 28.....	6 51.7	+1 36.5

An ill-defined cloudy patch on the Equatorial belt, following the Equatorial white spot and in the same latitude, was measured to ascertain whether the dark masses near the equator drifted with the same velocity as the white spot.

As the outline of this cloudy matter was not well defined, the micrometer measures are of necessity approximate.

An inspection of the above observations shows, however, that the drift of the dark matter in the Equatorial regions is essentially the same as for the white spots.

Two Oval White Spots on Belt No. 5.

Date.	*T*	*Long. from Red Spot*	*Dif. of long. of the two spots*	Remarks.
1881		H M	M	
Nov. 21...	foll. spot			Not measured.
Nov. 22...	7 58.4	+0 25.5		Lat. obs. −9″.63.
Nov. 24...	9 36.2	+0 26.1		
Dec. 1....	10 20.0	+0 24.4	60.0	
Dec. 6....	9 25.6	+0 23.3		
Dec. 23...	8 13.2	+0 12.5		
Dec. 28 ..	7 14.9	+0 06.6	42.0	
1882				
Jan. 9....	6 53.6	−0 05.4	46.3	Lat. obs. −10″.00.
Feb. 4....	8 02.3	−0 29.4	43.0	
Feb. 23...	8 34.2	−0 42.8	33.5	

Oval White Spot on Belt No. 3.

Date.	*T*	*Long. from Red Spot*	*Long. from Eq. White Spot*	Remarks.
1881		H M		
Nov. 1....	9 25.8	+4 07.5	+2 04.	Lat. obs. +4″.59.
Dec. 14...	9 34.0	+3 55.6	+1 41.1	

RED SPOT ON ♃.

LENGTH, BREADTH AND LATITUDE.

The following tables give the individual observations for the Length, Breadth and Latitude of the great Red Spot during the three oppositions of 1879, 1880 and 1881. h_0=distance in degrees from the central meridian at the time of observation. l=apparent length observed. L=Length of chord when on center of disc. B=Breadth. β=Latitude. All the quantities are reduced to the mean distance.

Date.	h_0	l	L	B	β	Remarks.
1879	°	″	″	″		
Sept. 11...	+ 18.1	10.57	11.12	3.26		
Sept. 18...					− 7.12	
Sept. 25...	+ 21.5	10.06	10.82		− 6.44	
	+ 12.8					Differential measure of length by Prof. Colbert.
Oct. 5 ...	− 10.6		13.27	2.38	− 7.56	
Oct. 10 ...	+ 22.6	10.90	11.80	3.05	− 7.11	
Oct. 14 ...	+ 29.3	11.36	13.03	3.61		
Oct. 15 ...	+ 2.4	13.20	13.21		− 7.00	
Oct. 20 ...	+ 53.2	7.33	12.24		− 7.14	
Oct. 22 ...				3.52		
Oct. 29 ...	+ 17.0	11.45	11.90	3.57	− 7.25	
1880						
Feb. 10...	− 1.2	12.78	12.78		− 6.00	
		Mean	12.25	3.46	− 6.95	
June 9 ..	+ 15.4	10.29	10.67			
June 16 ..	+ 9.4	12.35	12.53	3.73	− 6.79	
July 3...	− 10.0	11.03	11.30		− 7.01	
July 5...	− 10.4	11.10	11.28	3.72	− 6.95	
July 8...	+ 13.1	11.35	11.66	3.28		
July 20...	+ 1.4	12.10	12.10			
July 22...	+ 10.3	11.20	11.38		− 7.09	
July 27...	− 8.0	11.82	11.94	3.32		
July 29...					− 7.50	
Aug. 3 ..	+ 0.1	11.37	11.37			
Aug. 5 ..	− 1.5	11.98	11.98	3.41		
Aug. 6 ..					− 7.42	
Aug. 11 ..					− 7.46	
Sept. 4...	+ 6.0	10.83	10.90	3.41	− 7.32	
Sept. 6...	+ 7.9	11.84	11.95			
Sept. 9...	+ 7.5	11.95	12.03	3.87	− 6.81	
Sept. 21...	+ 4.7	11.43	11.47			
Oct. 13 ...	− 18.5	10.95	11.55	3.39	− 7.04	
Nov. 26...	+ 11.7	10.50	10.73	3.63	− 7.09	
Dec. 10...	+ 6.9	10.86	10.94			
Dec. 12...	− 29.3	10.28	11.79			
Dec. 12...	− 8.8	11.09	11.23			
1881						
Jan. 17 ...	+ 11.8	11.97	12.28	3.65	− 7.23	
		Mean	11.55	3.54	− 7.14	

Date.	h_0	l	L	B	β	Remarks.
1881	°	"	"	"		
June 20...					− 7.44	
June 22...		11.09	11.93			
July 28...	7.0	11.50	11.51		− 7.28	
Aug. 2...	10.0	11.46	11.64			
Aug. 4...					− 7.23	
Aug. 24...	8.8	11.22	11.36	3.54		
Sept. 21...	5.0	11.03	11.05			
Oct. 7...					− 7.50	
Oct. 24...					− 8.15	
Oct. 26..	14.6	10.97	11.34	3.41	− 6.95	
Nov. 21...	5.0	11.46	11.50	3.52		
Nov. 22...	7.0	11.49	11.57		− 7.33	
Dec. 28...	4.0	10.54	10.56			
1882						
Jan. 9....	10.0	10.50	10.65		− 7.27	
Feb. 4...	9.6	10.89	11.04	4.17	− 7.26	
Feb. 14...	4.0	11.43	11.45			
March 22.	6.0	11.19	11.25		− 7.57	
		Mean	11.30	3.66	− 7.40	

♃'S EQUATORIAL BELT.

The following table gives the angle of position, latitude and width of the Equatorial belt.

P=Angle of position of the North edge. β=Latitude of the North edge. W=Width.

The angle of position has been compared with the position of ♃'s Equator, as given in Marth's Ephemerides, published in the "Monthly Notices," Royal Astronomical Society.

Date.	P	$\beta N E$	W	♃ *Equator Marth Eph*	*Obs−Eph*
1879	°	″	″	°	°
Aug. 27...	64.4			65.8	−1.4
" 29...	65.5			65.8	−0.3
" 30...	65.3			65.9	−0.6
Sept. 3...	65.5	+2.53	6.09	65.9	−0.4
" 9...	66.7			65.9	+0.8
" 10...	65.7	+2.81	6.59	66.0	−0.3
" 16...	66.0			66.2	−0.2
" 18...		+2.20	6.90		
" 20...	66.6	+2.84	6.04	66.3	+0.3
" 24...	66.2	+3.22		66.3	−0.1
Oct. 2...	67.9			66.4	+1.5
" 6...	67.6	+2.57		66.4	+1.2
" 9...	67.1	+1.90	7.40	66.5	+0.6
" 10...	66.5			66.5	+0.0
" 14...	65.5	+2.81	6.25	66.6	−1.1
" 22...	65.6			66.6	−1.0
" 24...	66.7	+2.71	6.96	66.6	+0.1
" 29...	68.3			66.6	+1.7
Dec. 13...		+2.34	7.64		
1880					
Jan. 14...	64.2		7.10	65.2	−1.0
	Mean	+2.59	6.77		−0.01
June 16...	65.2	+2.57		65.6	−0.4
July 3...	65.9	+2.38	7.12	65.9	+0.0
" 5...	66.5	+2.59	7.77	66.0	+0.5
" 8...		+2.61	6.80		
" 20...	66.8		6.81	66.2	+0.6
" 22...	66.7	+2.04		66.2	+0.5
" 27...	66.2	+2.43	7.10	66.2	+0.0
Aug. 4...	67.0			66.3	+0.7
" 6...	67.1	+1.97	6.65	66.3	+0.8
" 11...	66.3			66.3	+0.0
" 12...	66.0			66.3	−0.3
" 26...	66.5			66.1	+0.4
Sept. 3...	65 0			66.1	−1.1
" 4...	66.6	+2.06	6.53	66.1	+0.5
" 9...		+2.27	6.45		
" 10...	66.8		7.11	66.0	+0.8
" 21...	65.5			65.8	−0.3
" 28...	66.0			65.7	+0.3

♃'s EQUATORIAL BELT.

Date.	*P*	*β N. E.*	*W*	♃ *Equator Marth Eph*	*Obs—Eph*	Remarks.
1879	°	″	M		°	
Oct. 13...	65.6	+ 2.44	6.93	65.5	+0.1	
" 23...	65.6		7.29	65.3	+0.3	
Nov. 2...	65.0			65.2	−0.2	
" 24...	64.5		7.68	65.0	−0.5	
" 26...	65.1	+ 2.23		65.0	+0.1	
Dec. 14...	66.2		7.22	65.2	+1.0	
1881						
Jan. 17...	65.2			65.4	−0.2	
" 19...	64.0		7.06	65.4	−1.4	
	Mean	+ 2.33	7.04		+0.09	
1881						
July 19...	75.1		5.99	74.3	+ 0.8	
July 28...	76.7			74.8	+ 1.9	
Aug. 2 ..			6.71			
Aug. 24 ..	77.9			75.9	+ 2.0	
Aug. 29 ..	76.0	+ 2.03	7.13	76.0	+ 0.0	
Oct. 5 ...	76.8		7.25	75.9	+ 0.9	
Oct. 7 ...	77.0			75.8	+ 1.2	
Oct. 8 ...	77.3	+ 2.01	6.87	75.8	+ 1.5	
Oct. 18 ...	76.6	+ 1.95		75.5	+ 1.1	
Oct. 26 ...	75.6	+ 2.37	6.94	75.1	+ 0.5	
Nov. 9...	74.3			74.5	− 0.2	
Nov. 14...	76.2			74.2	+ 2.0	
Nov. 26...	74.7			73.7	+ 1.0	
Dec. 1...	73.9			73.5	+ 0.4	
Dec. 7...	74.4			73.3	+ 1.1	
Dec. 10...	74.0		6.61	73.2	+ 0.8	
Dec. 17...	73 4	+ 2.14	7.30	73.0	+ 0.4	
1882						
Feb. 1....		+ 2.05	7.02			
Feb. 3....	74.2			72.9	+ 1.3	
Feb. 4....	72.7			72.9	− 0.2	
Feb. 8....	73.3			73.1	+ 0.2	
March 22..	74.8	+ 2.55	7.25	75.1	− 0.3	
March 31..	74.7			75.5	− 0 8	
	Mean	+ 2.16	6.91		+ 0.74	

ROTATION OF ♃ FROM THE GREAT RED SPOT.

The following table shows the error in longitude for every observation of the great red spot, as compared with an Ephemeris, extending from September 25, 1879 to March 29, 1882.

The first column is the date; second column, the number of days after the Epoch; third column, the time of transit reduced to the Zero Epoch; fourth column, the Ephemeris, corresponding to a uniform rotation period of $9^h\ 55^m\ 34^s.0$. Fifth column, Observation minus Ephemeris expressed in time, in which $5^m.6$ is equal to $1''$ of arc at mean distance.

Sixth column, the Ephemeris corresponding to the rotation period, $9^h\ 55^m\ 34^s.0 + t \times 0^s.00209$; seventh column, (Obs—Eph).

An examination of the residuals in column seven, shows that the formulas represent the individual observations very well, with the exception of about a month near the middle of the series.

The period, $9^h\ 55^m\ 34^s\ 0$ is probably too great for the date, September 25, 1879; but the observations made in 1878 are not sufficiently numerous to ascertain it with great precision.

			Rotation = 9 H 55 M 34.0 S		9 H 55 M 34.0 S $+t \times 0^s.00209$	
Date.	Days.	T_0	*Ephemeris*	*Obs—Eph*	*Ephemeris*	*Obs—Eph*
1879		H M	H M	M	H M	M
Sept. 25	0	11 27.6	11 28.9	− 1.3	11 28.9	−1.3
Oct. 5	10	9 40.7	9 42.5	− 1.8	9 42.5	−1.8
" 10	15	8 49.8	8 49.3	+ 0.5	8 49.3	+0.5
" 14	19	12 03.9	12 04.9	− 1.0	12 04.9	−1.0
" 15	20	7 59.6	7 56.1	+ 3.5	7 56.1	+3.5
" 29	34	9 26.7	9 25.4	+ 1.3	9 25.5	+1.2
1880						
Feb. 10	138	4 54.3	4 52.6	+ 1.7	4 54.3	0.0
May 6	224	15 26.5	15 26.1	+ 0.4	15 30.3	−3.8
June 9	258	13 29.3	13 22.5	+ 6.8	13 28.0	+1.3
" 16	265	14 12.9	14 07.2	+ 5.7	14 13.0	−0.1
July 3	282	13 13.4	13 05.4	+ 8.0	13 12.1	+1.3
" 5	284	14 49.6	14 43.2	+ 6.4	14 50.0	−0.4
" 8	287	12 19.4	12 12.2	+ 7.2	12 19.0	+0.4
" 15	294	13 02.9	12 56.9	+ 6 0	13 04.0	−1.1
" 20	299	12 07.9	12 03.7	+ 4.3	12 11.0	−3.1
" 22	301	13 46.6	13 41.5	+ 5.1	13 48.8	−2.2
" 27	306	12 54.4	12 48.3	+ 6.1	12 55.9	−1.5
" 29	308	14 32.7	14 26.7	+ 6.0	14 34.5	−1.8
Aug. 3	313	13 40.9	13 32.9	+ 8.0	13 41.0	−0.1
" 5	315	15 19.0	15 10.7	+ 8.3	15 19.0	0.0
" 6	316	11 10.1	11 01.9	+ 8.2	11 10.7	−0.6
" 11	321	10 18.5	10 08.7	+ 9.8	10 17.2	+1.3
Sept. 4	345	10 03.5	9 51.5	+12.0	10 01.5	+2.0
" 6	347	11 41.1	11 29.4	+11.7	11 39.6	+1.5
" 9	350	9 10.5	8 58.4	+12.1	9 08.7	+1.8
" 21	362	9 01.8	8 49.9	+11.9	9 00.9	+0.9
" 28	369	9 47.7	9 34.4	+13.3	9 45.9	+1.8
Oct. 1	372	7 19.1	7 03.5	+15.6	7 15.2	+3.9
" 5	376	10 33.1	10 19.2	+13.9	10 31.0	+2.1

			Rotation=9^H 55^M 34^S.0		9^H 55^M 34^S.0 + $t \times 0^s.00209$	
Date.	Days.	T_o	*Ephemeris*	*Obs−Eph*	*Ephemeris*	*Obs−Eph*
1881		H M	H M	M	H M	M
Oct. 13.......	384	7 08.2	6 54.9	+13.3	7 07.3	+0.9
" 23.......	394	5 25.2	5 08.6	+16.6	5 21.6	+3.6
Nov. 1.......	403	7 44.7	7 30.9	+13.8	7 44.5	+0.2
" 13.......	415	7 37.9	7 22.3	+15.6	7 36.8	+1.1
" 16.......	418	5 07.2	4 51.3	+15.9	5 06.0	+1.2
" 26.......	428	3 22.8	3 04.9	+17.9	3 20.3	+2.5
Dec. 3.......	435	4 07.0	3 49.4	+17.6	4 05.3	+1.7
" 8.......	440	3 15.7	2 56.2	+19.5	3 12.5	+3.2
" 10.......	442	4 53.2	4 36.0	+18.2	4 51.4	+1.8
" 12.......	444	6 31.6	6 11.9	+19.7	6 28.5	+3.1
" 27.......	459	3 54.0	3 32.2	+21.8	3 49.9	+4.1
" 31.......	463	7 10.2	6 47.9	+22.3	7 05.9	+4.3
1881						
Jan. 10.......	473	5 25.3	5 01.7	+23.6	5 20.6	+4.7
" 17.......	480	6 08.2	5 46.3	+21.9	6 05.7	+2.5
" 27.......	490	4 26.4	3 59.9	+26.5	4 20.1	+6.3
June 17.......	631	15 17.5	14 43.6	+33.9	15 17.2	+0.3
" 20.......	634	12 47.8	12 12.6	+35.2	12 46.5	+1.3
" 22.......	636	14 25.8	13 50.4	+35.4	14 24.5	+1.3
July 28.......	672	14 02.6	13 24.7	+37.9	14 02.7	−0.1
Aug. 2.......	677	13 10.4	12 31.6	+38.8	13 10.1	+0.3
" 9.......	684	13 55.5	13 16.2	+39.3	13 55.6	−0.1
" 24.......	699	11 21.3	10 36.6	+44.7	11 17.7	+3.6
Sept. 5.......	711	11 11.2	10 28.0	+43.2	11 10.5	+0.7
" 21.......	727	14 20.4	13 35.0	+45.4	14 19.5	+0.9
" 22.......	728	10 10.6	9 26.2	+44.4	10 10.8	−0.2
Oct. 7.......	743	7 33.7	6 46.6	+47.1	7 33.1	+0.6
" 9.......	745	9 11.8	8 24.5	+47.3	9 11.3	+0.5
" 24.......	760	6 34.2	5 44.9	+49.3	6 33.5	+0.7
" 26.......	762	8 10.6	7 22.7	+47.9	8 11.6	−1.0
Nov. 5.......	772	6 26.2	5 36.3	+49.9	6 26.5	−0.3
" 9.......	776	9 44.6	8 52.0	+52.6	9 42.7	+1.9
" 19.......	786	7 59.0	7 05.6	+53.4	7 57.7	+1.3
" 21.......	788	9 35.9	8 43.4	+52.5	9 35.8	+0.1
" 22.......	789	5 29.1	4 34.5	+54.6	5 27.0	+2.1
" 24.......	791	7 06.6	6 12.4	+54.2	7 05.2	+1.4
Dec. 1.......	798	7 53.1	6 57.0	+56.1	7 50.6	+2.5
" 4.......	801	5 22.1	4 26.0	+56.1	5 20.1	+2.0
" 6.......	803	7 00.6	6 03.8	+56.8	6 58.1	+2.3
" 14.......	811	3 37.2	2 39.0	+57.6	3 35.0	+2.2
" 18.......	815	6 53.4	5 55.2	+58.2	6 51.1	+2.3
" 23.......	820	5 59.7	5 02.0	+57.7	5 58.6	+1.1
" 28.......	825	5 07.1	4 08.8	+58.3	5 06.1	+1.0
1882						
Jan. 9.......	837	4 56.7	4 00.3	+56.4	4 59.3	−2.6
" 11.......	839	6 35.4	5 38.1	+57.3	6 37.4	−2.0
" 14.......	842	4 05.7	3 07.1	+58.6	4 06.9	−1.2
Feb. 2.......	861	4 41.8	3 43 2	+58.6	4 45.6	−3.8
" 4.......	863	6 24.0	5 21.1	+62.9	6 23.8	+0.2
" 7.......	866	3 53.8	2 50.1	+63.7	3 53.2	+0.6
" 9.......	868	5 31.5	4 28.0	+63.5	5 31.4	+0.1
" 14.......	873	4 40.2	3 34.8	+65.4	4 39.0	+1.2
" 23.......	882	7 03.4	5 57.2	+66.2	7 02.8	+0.6
Mar. 22.......	909	4 19.8	3 09.0	+70.8	4 18.6	+1.2
" 29.......	916	5 03.0	3 53.7	+69.3	5 04.3	−1.3

ROTATION OF ♃ FROM EQUATORIAL WHITE SPOTS.

$T'_{\circ}$ = observed passage over the central meridian, reduced to Sept. 25, 1879.

The same reduction numbers were used for the equatorial spots as for the great red spot. The error introduced may amount to ± 0.1 minute.

No one period of rotation will satisfy the observations for the equatorial white spots. For the two spots observed in 1880, the motion was remarkably uniform, as the small residuals in the column (Obs – Eph) will show. But during 1881, the single spot, observed continuously for a period of 252 days, indicated sudden deviations in its apparent place, probably due to change in the shape of the object observed. The longitudes, as determined, were correct within one minute of time, but the comparison with the ephemeris shows a maximum displacement of sixteen minutes of time, or more than 3″ of arc at mean distance.

Rotation = $9^{h}\ 50^{m}\ 00^{s}.5$

Date.	Days	$T_{\circ}$	Ephemeris	Obs – Eph	Remarks.
1879		H M	H M	M	
Sept. 10...	–15	12 24.8	12 57.9	–33.1	From Sept. 10, 1879, to
" 20...	– 5	8 19.7	8 58.1	–38.4	July 8, 1880, the exact Rotation period is $9^{h}50^{m}03^{s}.5$
1880					
July 8...	287	12 15.3	12 15.3	0.0	
" 17...	296	12 36.7	12 36.5	+ 0.2	
" 24...	303	11 47.4	11 45.7	+ 1.7	
Aug. 4...	314	13 17.2	13 15.0	+ 2.2	
" 6...	316	14 24.3	14 26.1	– 1.8	
" 11...	321	12 26.6	12 26.0	+ 0.6	
Sept. 3...	344	11 06.7	11 06.6	+ 0.1	
" 10...	351	10 16.5	10 16.7	– 0.2	
" 24...	365	8 35.6	8 37.2	+ 1.6	
Oct. 1...	372	7 47.6	7 47.3	– 0.3	

Rotation = $9^{h}\ 50^{m}\ 09^{s}.8$

Date.	Days	$T_{\circ}$	Ephemeris	Obs – Eph
Oct. 28...	399	9 18.5	9 18.5	0.0
Nov. 2...	404	7 20.3	7 20.5	– 0.2
" 8...	410	10 53.7	10 52.9	+ 0.8
Dec. 2...	434	5 20.4	5 22.4	– 2.0
" 6...	438	7 50.0	7 43.9	+ 6.1
" 9...	441	4 40.4	4 35.1	+ 5.3
" 31...	463	7 44.2	7 43.7	+ 0.5
1881				
Jan. 30...	493	5 44.5	5 45.6	– 1.1

EQUATORIAL WHITE SPOTS.

H M S
9 50 09.8

Date.	Days.	T_0	*Ephemeris*	*Obs—Eph*	Remarks.
1881		H M	H M	M	
July 22...	666	13 40.3	13 40.4	— 0.1	
Aug. 9...	684	14 27.9	14 27.5	+ 0.4	
Sept. 1...	707	13 23.4	13 16.4	+ 7.0	
" 21...	727	15 16.9	15 14.4	+ 2.5	
Oct. 8...	744	10 47.5	10 31.5	+16.0	
" 18...	754	6 46.6	6 35.4	+11.2	
" 20...	756	7 56.3	7 45 9	+10.4	
Nov. 5...	772	7 27.3	7 22.3	+ 5.0	
" 9...	776	9 47.7	9 43.8	+ 3.9	
" 14...	781	7 50.9	7 46.0	+ 4.9	
" 21...	788	7 09.3	6 58.8	+10.5	
" 24...	791	4 03.3	3 49.9	+13.4	
" 26...	793	5 14.4	5 00.4	+14.0	
Dec. 7...	804	6 41.5	6 35.3	+ 6.2	
" 9...	806	7 50.7	7 45.8	+ 4.9	
" 10...	807	3 31.1	3 26.2	+ 4.9	
" 14...	811	5 52.0	5 47.7	+ 4.3	
" 23...	820	6 12.1	6 11.3	+ 0.8	
" 28...	825	4 13.8	4 13.3	+ 0.5	
1882					
Jan. 17...	845	6 15.7	6 11.5	+ 4.2	
" 22...	850	4 14.0	4 13.5	+ 0.5	
" 24...	852	5 24.0	5 24.0	+ 0.0	
" 29...	857	3 33.8	3 26.0	+ 7.8	
Feb. 2...	861	5 51.7	5 47.5	+ 4.2	
" 4...	863	6 58.3	6 58.7	— 0.4	
" 7...	866	3 52.1	3 49.7	+ 2.4	
" 9...	868	5 01.6	5 00.2	+ 1.4	
" 16...	875	4 25.6	4 13.1	+12.5	
Mar. 1...	888	7 00.4	6 58.2	+ 2.2	
" 22...	909	4 33.0	4 36.6	— 3.6	
" 31...	918	5 00.1	5 00.1	+ 0.0	

DRAWINGS OF JUPITER.

The accompanying sketches of the planet Jupiter exhibit the more marked phenomena seen on his disc, from September 1879 to March 1882.

September 20, 1879, shows the system of belts and the equatorial white spot.

October 15, 1879, shows the great red spot and the equatorial white spot nearly in conjunction.

July 3, 1880, shows the second satellite just entering on the red spot, at 15^h $43^m.5$, and nine minutes later, the satellite nearly over the center of the spot.

So soon as the satellite touched the end of the red spot, it formed a notch, as is shown in the drawing, and when completely on the red spot, it appeared apparently as white as when outside the disc of the planet.

The equatorial white spot is also shown following the red spot.

August 4, 1880, shows two oval white spots on belt No. 6, a small black spot on belt No. 2, and two equatorial white spots.

September 9, 1880, shows the red spot, and a peculiar spur under it, apparently joined to the equatorial belt; also a small black spot on belt No. 2.

November 1, 1880, shows the shadow of the first satellite on the disc, and the shadow of the second satellite projected on the red spot. The shadow on the red spot was not quite as black as the shadow on the disc.

Two dusky spots are also shown on belt No. 3.

October 10, 1881, shows five oval white spots on belt No. 6.

December 1, 1881, shows the great red spot and the peculiar spur under it, as seen on September 9, 1880; also a minute black spot on belt No. 1, and two oval white spots south of the great red spot.

December 28, 1881, shows the drift of the two oval white spots in longitude, with reference to the great red spot;

THE EQUATORIAL,

DEARBORN OBSERVATORY, CHICAGO.

OBJECT GLASS.— { Focal Length, 23 feet.
Clear Aperture, 18½ inches.

also the principal equatorial white spot preceding the red spot, and a white equatorial rift following the spur.

October 25, 1881, shows four oval white spots on belt No. 6, and a minute white spot on the south margin of the equatorial belt.

March 22, 1882, shows the great red spot and the equatorial white spot nearly in conjunction.

In all of the sketches the whole disc of the planet has been represented as correctly as possible.

It will be noticed that belt No. 3 was dark during 1879 and 1880, but assumed a reddish hue in 1881 ; being very similar in color to the equatorial belt.

The shading about the poles is never seen as marked as it is usually represented in the drawings of this planet.

THE EQUATORIAL.

The Equatorial was constructed by Messrs. Alvan Clark & Sons, and has a focal length of 23 ft., and a clear aperture of 18½ inches.

The tube is of mahogany, mounted after the German style.

The polar-axis is supported by a cast-iron frame resting on a single block of stone 8½ ft. in height.

The Right Ascension Circle is 20 inches in diameter, divided to 30 seconds, and read by two microscopes to single seconds.

The Declination Circle is 30 inches in diameter, divided to 5 minutes, and read by two microscopes to 10 seconds.

On the rim of each circle, coarse divisions have been painted for quickly pointing the telescope. The Right Ascension may be readily set within 1 minute of time, and the Declination within 5 minutes of arc.

The driving clock is Bond's spring governor, which, with occasional repairs, performs very satisfactorily.

The parallel wire Micrometer was made by Clark & Sons. It is provided with six positive eye-pieces ; the powers

of which, as determined by Mr. S. W. Burnham, are as follows:

No. 0, 120.	No. III, 390.
" I, 190.	" IV, 638.
" II, 292.	" V, 925.

The position circle is 8 inches in diameter, divided to 30 minutes, and provided with two verniers, which read to single minutes.

The adopted value of one revolution of the micrometer screw is 11″.42, and the thickness of the micrometer wire is 0″.30.

A second screw placed opposite the micrometer-head, carries both wires across the field when desired.

The wires are illuminated by a small gas burner, placed at the extremity of a short tube, inclined at an angle of 45 degrees to the plane of the circle.

The finder telescope has a clear aperture of 3¾ inches.

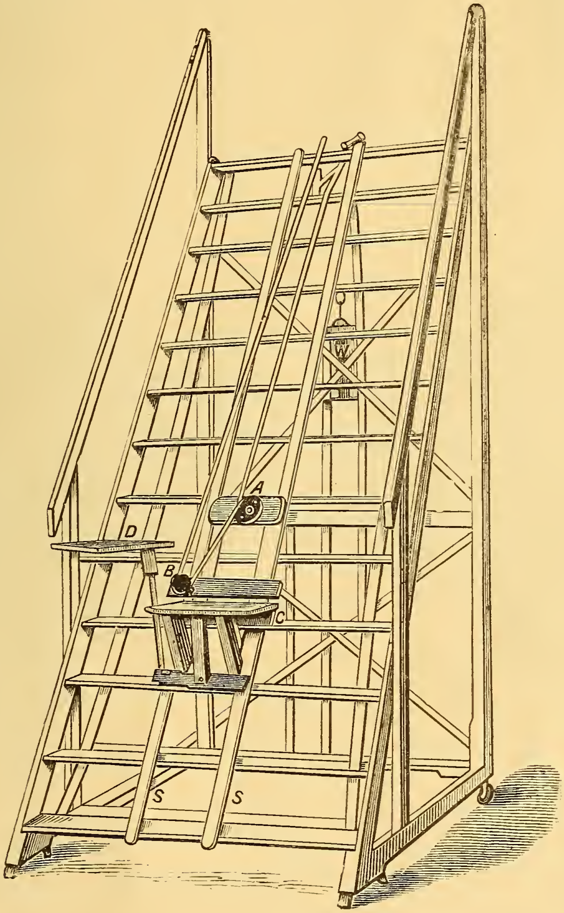
The Equatorial Observing Chair now in use was devised in 1880. A description of it has been published in the Monthly Notices of the Royal Astronomical Society, the English Mechanic, and the Sidereal Messenger.

The mechanism is so exceedingly simple, that it readily commends itself to the practical Astronomer. The following is a brief description:

Over the center of a step-ladder, 11 ft. in height, and 5 ft. in width, are screwed two strips of pine, s s, two inches in width, which pass from the top to the bottom of the steps; the distance between them being about seven inches. A light wooden frame is made to slide on this track, to which the observing seat, c, is attached. The seat is 20 inches in length and 12 inches in depth. In order to keep it in place, the strips, s s, are beveled on the inside, with corresponding bevels in the sliding frame, analogous to the slide-rest of a lathe. The seat when in use is raised and lowered by the following device:

To the top of the steps, on the right-hand side, in the figure, is attached a woven cord ⅜ of an inch in diameter, which is passed *once* around a fixed wooden drum, A, 5 inches in diameter, attached to the frame carrying the seat, thence over a loose pulley, B, near the seat, thence back again to

the top of the steps, over a loose pulley, not shown in the figure, thence over the weight-pulley, W; the end being fastened on the right-hand side. The weight slides in vertical tracks, attached to the rear of the step-ladder, and is just sufficient to balance the seat.



The seat, therefore, is held in position simply by the torsion-friction of the cord around the fixed drum A, without the use of any clamp or stop. The whole weight of the seat and frame is about 15 lbs., and a very slight force, viz. : 10 lbs., will cause it to slide up the track when unloaded.

When seated in the chair, a slight pull downwards, on the rope to which the counterpoise is attached, causes it to descend any amount desired.

As the whole merit of our apparatus consists in the ease and celerity with which the observer may secure the proper elevation for the eye, it may be added that the seat is completely under control; it may be moved one inch or a foot, almost instantaneously, and in this respect is infinitely superior to any screw or rack motion.

For the upward movement it is necessary to rest one's weight on the steps.

As there are no ratchets or stops, but simply a rope wrapped around a smooth drum, the chair can be manipulated in the dark without difficulty. The cost of applying this apparatus to the step-ladder was about five dollars.

When using the micrometer, a small table, D, for holding the note-book, lamp, eye-pieces, etc., is attached on the side of the seat and may be removed at pleasure.

The step-ladder, itself, is mounted on castors and is easily shifted to any required position.

When micrometric measures are not in progress, the seat may be slid to the top of the steps, where it is out of the way, and the ladder may be used in the ordinary way without inconvenience.

The following are the dimensions of our step-ladder and chair:

Length of steps, 5 ft.
Distance between the steps, $9\frac{1}{4}$ in.
Depth of step, $7\frac{1}{2}$ in.
Height of ladder, 11 ft.
Depth of ladder, $6\frac{1}{2}$ ft.
Size of upright frame, 3 in. by $1\frac{3}{4}$ in.
Size of hand-rail, $2\frac{1}{2}$ in. by $1\frac{3}{4}$ in.
Seat, 12 in. by 20 in.
Table, 14 in. by 20 in.
Distance from seat to drum, D, 18 in.

A step-ladder built to conform to the radius of the telescope, and provided with a sliding seat similar to the one described, could be mounted on fixed tracks so as to be always at the right distance from the telescope, but we doubt whether it would be as convenient as one moving freely over the floor in any direction.


JUPITER
1879. Sept. 20th. 9h.-45m.
JUPITER
1879. Oct. 15th. 8h.-07m.

JUPITER

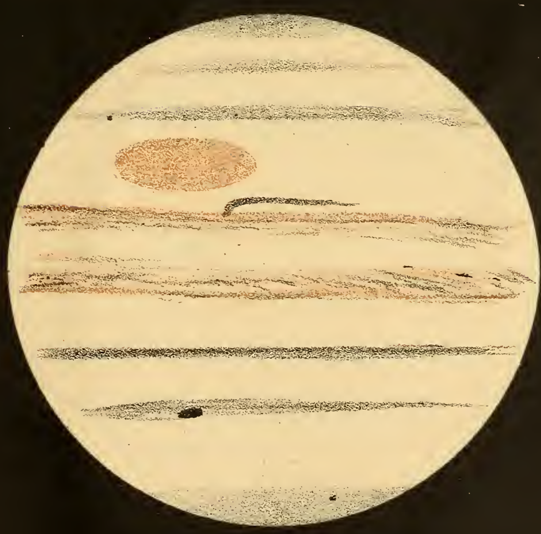
1880. JULY, 3RD. 15H.-43-5M.

JUPITER

1880. JULY, 3RD. 15H.-52M.

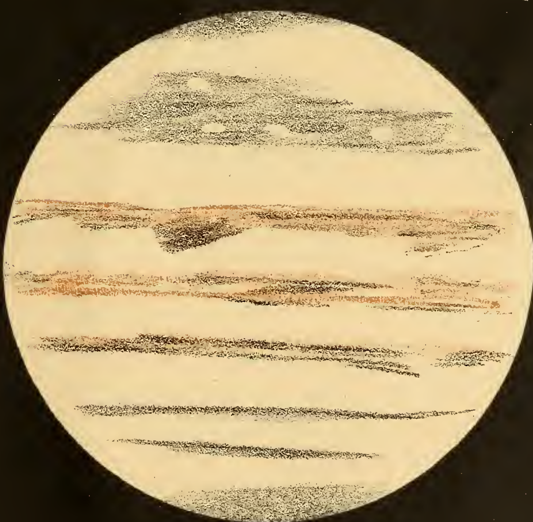
JUPITER
1880. Aug. 4th. 15h.–15m.

JUPITER
1880. Sept. 9th. 11h.–00m.



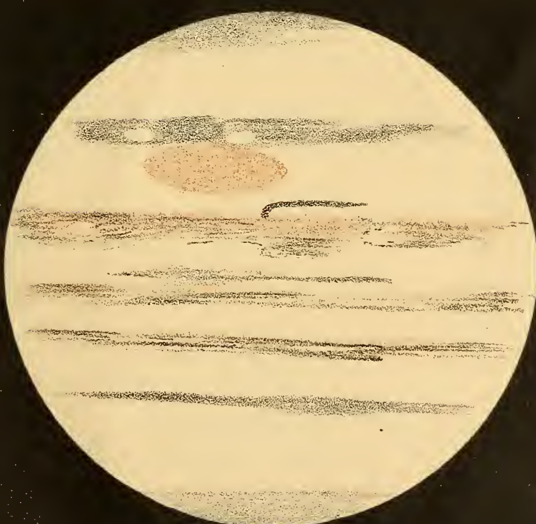
JUPITER
1880. Nov. 1st. 7h.-55m.

JUPITER
1881. Oct. 10th. 10h.-35m.



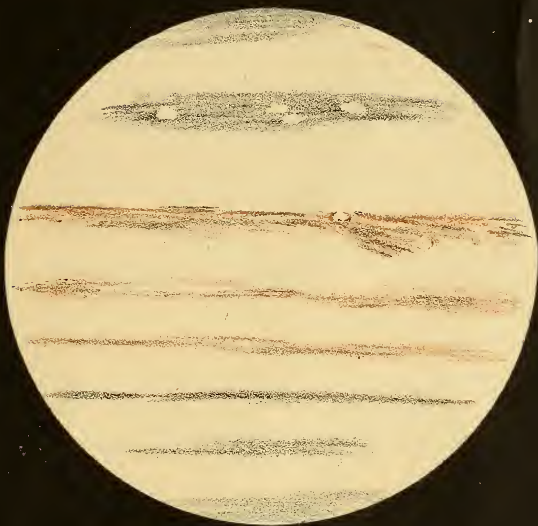
JUPITER
1881. DEC. 1 ST. 10 H.–30 M.

JUPITER
1881. DEC. 28 TH. 7 H.–30 M.



JUPITER

1881. OCT. 25TH. 9H.–55M.



JUPITER

1882. MAR. 22ND. 7H.–25M.